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OF THE
ROYAL
MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA,
MICROSCOPY, &c.

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PREFACE.

THE substantial increase during the present year in the finances of the Society, has rendered it possible to increase the quantity of matter in the Journal, and it is hoped it will be found to be improved in quality also.

In addition to the "TRANSACTIONS" and "PROCEEDINGS" of the Society, the "BIBLIOGRAPHY" and "RECORD" now form a large part of each number. The former provides a classified Index, in English, to the contents of upwards of three hundred British and Foreign Scientific Journals and Transactions,* whilst the latter consists of abstracts of or extracts from the more important of the articles noted in the Bibliography.

The object of this part of the Journal is to meet a wish which has been for many years expressed by the Fellows—not only those resident in the country, to whom the Library is less accessible, but those in London also—that steps should be taken for obviating to some extent the difficulty that has hitherto existed (owing to the great development in modern times of Periodical Scientific Literature) in ascertaining what is being done by Biologists of this and other countries.

Whilst the Annual Records published in this country and abroad (all of which are to be found in the Library) are invaluable as books of reference beyond anything to which a Journal issued bi-monthly could attain, the feeling has been that a more *readable* account of the results of research would be useful, and, if possible, one not so much out of date. As an instance, Mr. Geddes' very interesting researches on Chlorophyll in the Green Planariæ may be referred to. In ordinary course a more or less brief reference to this observation would appear in the Annual Summaries of the second (in a few cases the first) year after its announcement. It is obviously very desirable that the Fellows should, in such a case,

* In a memorial recently presented to Professor E. Coues, of the United States, signed by Professors Flower and Huxley, Mr. Darwin, and others, the memorialists say:—"The want of indexes to the ever-increasing mass of Zoological literature has long been felt by all workers in every department of science, but the enormous labour of compilation has hitherto deterred many from undertaking a task so appalling."

be in possession of fuller and earlier information of the author's views.*

As the Society's domain includes the *Invertebrata* and the *Cryptogamia* generally, with the *Embryology* and *Histology* of the higher Animals and Plants, and *Microscopy* (properly so called), the Bibliography and Record extend to those subjects also.

The difficulty that has hitherto prevented a nearer approach to completeness in the Bibliography—that of perfecting arrangements at short notice for obtaining ready access to all the Journals and Transactions which it is intended ultimately to include—is now, it is hoped, in a fair way to be overcome.

With regard to the Record, the matter stands on a different footing, the greater or less completeness in this case necessarily depending upon the Society's finances. Whilst the fullest use has been made of the means at command, the result falls short of what it is hoped will ultimately be accomplished. It requires, however, a larger expenditure than the Society can at present prudently devote to that purpose.

It will have been obvious that the production of the later numbers of the Journal was beyond the powers of any one person (at least when the only time that could be devoted to it was by way of relaxation from engagements having a primary claim); and the Society have been fortunate in obtaining the assistance of Mr. T. Jeffery Parker, Mr. A. W. Bennett, and Professor F. Jeffrey Bell, to whose ability and energy the success of what has been accomplished is very largely due. As their share in the production of the Journal is now so important, their names will in future be associated with it.

An acknowledgment is also due to the Publication Committee (consisting of Dr. Braithwaite, Dr. Millar, Mr. Stephenson, and Mr. Stewart) for much care bestowed on the revision of the Record, and for many suggestions which have contributed to the improvement of the Journal.

FRANK CRISP.

* Whilst we fully recognize the compliment that is involved in the transfer of the foreign abstracts of the Record to other pages, and the exceptional appreciation evinced by referring to the original foreign source only (the editor evidently intending thereby to show that he is prepared to take the responsibility of having the abstracts attributed to himself), it would, on the whole, we suggest, be better to adhere to the rule which we uniformly observe, of giving *both* sources in the reference note.

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MEMORANDUM AS TO THE BIBLIOGRAPHY.

The primary object of the Bibliography is to note all *original articles and papers*. Whilst not impossible to include *everything* (within the scope of the Bibliography) contained in the Journals, Transactions, &c., in the list appended, it would obviously not be beneficial to do so, as the original papers would then be lost in a mass of less important titles.

There are therefore omitted (subject to special exceptions):

- (1) Abstracts of papers appearing in other Journals,
- (2) Correspondence,
- (3) Discussions at Meetings of Societies,
- (4) Notes,
- (5) Reviews of Books, &c.,
- (6) Articles copied into another publication in the *same language* or translated from the English language.

The Bibliography is classified as follows :—

ZOOLOGY.

A. General (including Embryology and Histology of the Vertebrata).

B. Invertebrata.

MOLLUSCA.

MOLLUSCOIDA.

ARTHROPODA.

(*α*) INSECTA (omitting lists and descriptions of new species, local fauna, &c.).

(*β*) MYRIAPODA.

(*γ*) ARACHNIDA.

(*δ*) CRUSTACEA.

VERMES.

ECHINODERMATA.

CŒLENTERATA.

PORIFERA.

PROTOZOA.

BOTANY.

A. General (including Embryology and Histology of the Phanerogamia).

B. Cryptogamia.

CRYPTOGAMIA VASCULARIA.

MUSCINEÆ.

CHARACEÆ.

FUNGI.

LICHENES.

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(2) Verhandelingen.

HAARLEM. Hollandsche Maatschappij der Wetenschappen (Société Hollandaise des Sciences)—(1) Archives Néerlandaises des Sciences Exactes et Naturelles. (2) Natuurkundige Verhandelingen.

LEIDEN. Nederlandsche Dierkundige Vereeniging—Tijdschrift.

NIJMEGEN. Nederlandsche Botanische Vereeniging—Verslagen en Mededeelingen. (Nederlandsch Kruidkundig Archief.)

UTRECHT. Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen—Natuurkundige Verhandelingen.

„ Physiologisch Laboratorium der Utrechtsche Hoogeschool—Onderzoekingen.

BATAVIA. Natuurkundig Tijdschrift voor Nederlandsch Indië.

„ Bataviaasch Genootschap van Kunsten en Wetenschappen—(1) Notulen van de Algemeene en Bestuurs-Vergaderingen. (2) Tijdschrift voor Indische Taal- Land- en Volkenkunde. (3) Verhandelingen.

DENMARK.

Botanisk Tidsskrift. (Journal de Botanique.)

Naturhistorisk Tidsskrift.

COPENHAGEN. K. Danske Videnskabernes Selskab—(1) Oversigt. (2) Skrifter.

SWEDEN and NORWAY.

Archiv for Mathematik og Naturvidenskab.

Botaniska Notiser.

Nyt Magazin for Naturvidenskaberne.

LUND. Universitet—Års-skrift (Acta).

STOCKHOLM. K. Svenska Vetenskaps-Akademien—(1) Ofversigt af . . . Förhandlingar. (2) Handlingar.

UPSALA. R. Societas Scientiarum Upsaliensis—Nova Acta.

RUSSIA.

HELSINGFORS. Societas pro Fauna et Flora Fennica—(1) Meddelanden. (2) Acta.

MOSCOW. Société Impériale des Naturalistes—(1) Bulletin. (2) Nouveaux Mémoires.

ODESSA. Neurussische Naturforschende Gesellschaft—Denkschriften.

ST. PETERSBURG. Académie Impériale des Sciences—(1) Bulletin. (2) Mémoires.

„ Société Impériale des Naturalistes—Bulletin.

„ Societas Entomologica Rossica—Hortæ.

„ Russische Entomologische Gesellschaft—Arbeiten.

SWITZERLAND.

Archives des Sciences Physiques et Naturelles.

BASEL. Naturforschende Gesellschaft—Verhandlungen.

„ Schweizerische Palæontographische Gesellschaft—Abhandlungen.

- BERN. Naturforschende Gesellschaft—Mittheilungen.
 CHUR. Naturforschende Gesellschaft Graubündens—Jahresberichte.
 GENEVA. Société de Physique et d'Histoire Naturelle—Mémoires.
 „ Institut National Genevois—(1) Bulletin. (2) Mémoires.
 LAUSANNE. Société Vaudoise des Sciences Naturelles—Bulletin.
 SCHAFFHAUSEN. Schweizerische Entomologische Gesellschaft—Mittheilungen.
 ZÜRICH. Allgemeine Schweizerische Gesellschaft für die gesammten Naturwissenschaften (Société Helvétique des Sciences Naturelles)—Neue Denkschriften (Nouveaux Mémoires).
 „ Naturforschende Gesellschaft—(1) Vierteljahrsschrift. (2) Abhandlungen.

FRANCE.

- Adansonia.
 Annales des Sciences Naturelles—Botanique.
 „ „ „ Zoologie.
 Archives de Zoologie Expérimentale et Générale (Lacaze-Duthiers).
 Archives de Physiologie normale et Pathologique (Brown-Séquard).
 Brebissonia.
 Bulletin Scientifique du Département du Nord et des Pays voisins.
 Journal de l'Anatomie et de la Physiologie (Robin).
 „ Conchyliologie.
 „ Micrographie.
 Revue Bryologique.
 „ Internationale des Sciences.
 „ et Magazin de Zoologie pure et appliquée.
 „ Mycologique.
 „ des Sciences Naturelles.
 „ Scientifique.
 AMIENS. Société Linnéenne du Nord de la France—(1) Bulletin mensuel. (2) Mémoires.
 BORDEAUX. Société des Sciences Physiques et Naturelles—Mémoires.
 „ Société Linnéenne—Actes.
 CAEN. Société Linnéenne de Normandie—(1) Bulletin. (2) Mémoires.
 CHERBOURG. Société Nationale des Sciences Naturelles—Mémoires.
 LILLE. Société des Sciences—Travaux et Mémoires.
 LYONS. Académie des Sciences, Belles-Lettres et Arts—Mémoires.
 „ Société Linnéenne—Annales.
 MARSEILLE. Académie des Sciences, Belles-Lettres et Arts—Mémoires.
 MONTPELLIER. Académie des Sciences et Lettres—Mémoires.
 PARIS. Académie des Sciences—(1) Comptes Rendus. (2) Mémoires. (3) Mémoires présentés par divers Savants.
 „ Association Française pour l'Avancement des Sciences—Comptes Rendus.
 „ Laboratoire d'Histologie du Collège de France—Travaux.
 „ Société de Biologie—(1) Comptes Rendus des Séances. (2) Mémoires.
 „ Société Botanique de France—Bulletin.
 „ Société Entomologique de France—Annales.
 „ Société Géologique de France—(1) Bulletin. (2) Mémoires.
 „ Société Philomathique—Bulletin.
 „ Société Linnéenne de Paris—Bulletin mensuel.

PARIS. Muséum d'Histoire Naturelle—Nouvelles Archives.

„ Société Zoologique de France—Bulletin.

TOULOUSE. Académie des Sciences, Inscriptions et Belles-Lettres—Mémoires.

„ Société d'Histoire Naturelle—Bulletin.

BELGIUM.

BRUSSELS. Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique—(1) Bulletins. (2) Mémoires. (3) Mémoires Couronnés et Mémoires des Savants Étrangers, 4to. (4) Mémoires Couronnés et autres Mémoires, 8vo.

„ Société Royale de Botanique de Belgique—Bulletin.

„ Société Belge de Microscopie—Annales : (1) Mémoires ; (2) Bulletin.

„ Société Entomologique de Belgique—Annales (including Comptes Rendus).

„ Société Malacologique de Belgique—Annales (including Procès-Verbaux).

LIÉGE. Société Géologique de Belgique—Annales : (1) Mémoires ; (2) Bulletin.

ITALY.

NUOVO Giornale Botanico Italiano.

BOLOGNA. Accademia di Scienze dell' Istituto—(1) Memorie. (2) Rendiconti.

FLORENCE. Società Entomologica Italiana—Bullettini.

„ Società Malacologica Italiana—Bullettini.

GENOA. Museo Civico di Storia Naturale—Annali.

MILAN. Società Crittogamologica Italiana—Atti.

„ Società Italiana di Scienze Naturali—Atti.

„ R. Istituto Lombardo di Scienze e Lettere—(1) Rendiconti. (2) Memorie.

MODENA. Società dei Naturalisti—Annuario.

NAPLES. R. Accademia delle Scienze Fisiche e Matematiche—(1) Atti. (2) Rendiconti.

„ Zoologische Station—(1) Mittheilungen. (2) Fauna und Flora des Golfes von Neapel.

PADUA. Società Veneto-Trentina di Scienze Naturali—Atti.

PAVIA. Laboratorio di Botanico—Archivio triennale.

PISA. Società Toscana di Scienze Naturali—Atti.

ROME. R. Accademia dei Lincei—Atti : (1) Transunti ; (2) Memorie.

„ R. Comitato Geologico d'Italia—Bollettini.

TURIN. R. Accademia delle Scienze—(1) Atti. (2) Memorie.

VENICE. R. Istituto Veneto di Scienze, Lettere ed Arti—(1) Atti. (2) Memorie.

SPAIN.

MADRID. Sociedad Española de Historia Natural—Anales.

PORTUGAL.

LISBON. Academia R. das Sciencias—(1) Jornal de Sciencias Mathematicas, Physicas e Naturaes. (2) Memorias.

THE Royal Microscopical Society.

(Founded in 1839. Incorporated by Royal Charter in 1866.)

The Society was established for the communication and discussion of observations and discoveries (1) tending to improvements in the construction and mode of application of the Microscope, or (2) relating to Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and *Ex-officio* Fellows.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is £2 2s., payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of £2 2s. Future payments of the former may be compounded for at any time for £31 10s. Fellows elected in October, November, or December, are not called upon for a subscription during the succeeding year, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

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The Council, by whom the affairs of the Society are managed, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Fellows.

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings ("Scientific Evenings") are devoted to the exhibition of Apparatus and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

The Journal, containing the Transactions and Proceedings of the Society, with a Record of Current Researches relating to Invertebrata, Cryptogamia, Microscopy, &c., is published bi-monthly, and is forwarded *gratis* to all Ordinary and *Ex-officio* Fellows residing in countries within the Postal Union.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

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* * * Omissions having occasionally occurred in the Obituary Notices at the Anniversary Meetings of the Society, it is requested that any information with respect to Deceased Fellows, as also notice of changes of residence, be addressed to the Assistant Secretary, at the Society's Library, King's College, Strand, W.C.

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THOMAS BELL, F.R.S.	1844-5
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* *Fellows who have compounded for their Annual Subscriptions.*

Elected.	
1861	Abbott, Francis, F.R.A.S. <i>The Observatory, Hobart Town, Tasmania.</i>
1866	* Abercrombie, John, M.D. (Cantab.), F.R.C.P. <i>13, Suffolk-square, Cheltenham.</i>
1872	Abraham, Phineas. <i>Royal College of Surgeons in Ireland, Museum Department, Dublin.</i>
1871	Ackland, William, L.S.A. <i>416, Strand, W.C.</i>
1878	Alabone, Edwin W., M.D., M.R.C.S. <i>Lynton House, Mildmay-road, N.</i>
1858	Alexander, Lieut.-General Sir James, R.A., Kt., C.B. <i>35, Bedford-place, Russell-square, W.C.</i>
1867	Allbon, William. <i>525, New Oxford-street, W.C.</i>
1859	Allen, Charles Joseph Hyde, F.L.S., G.S., Z.S. <i>4, Park-crescent, Portland-place, N. W.</i>
1870	Allen, Daniel. <i>69, Union-street, Ryde, Isle of Wight.</i>
1869	* Ames, George Acland. <i>Union Club, Trafalgar-square, W.C.</i>
1872	Angell, Arthur, jun. <i>Hants County Laboratory, Southampton.</i>
1845	Ansted, David Thomas, M.A. (Cantab.), F.R.S., F.G.S., F.R.G.S., F.C.P.S., Hon. Mem. R.I.B.A., Ord. Hellen. "du Sauveur" <i>Eq., Soc. Reg. Sci. Leod. Corr. Mem.</i> <i>The Red House, Melton, Woodbridge.</i>
1870	Anthony, John, M.D., M.R.C.P.L. <i>6, Greenfield-crescent, Edgbaston, Birmingham.</i>
1871	Armstrong, Thomas. <i>Highfield Bank, Urmston, Manchester.</i>
1872	Atkinson, John Thomas. <i>The Quay, Selby, Yorkshire.</i>
1874	Badcock, John. <i>2, Banbury-road, South Hackney, E.</i>
1863	Baker, Charles. <i>244, High Holborn, W.C.</i>

Elected.

- 1867 Bannister, Richard.
The Laboratory, Inland Revenue, Somerset House, W.C.
- 1867 Barber, John.
31, Randolph-crescent, Maida-hill, W.
- 1867 *Barker, Samuel, M.D., L.R.C.P. Edin., M.R.C.S., F.M.S., &c.
24, Eaton-place, Brighton.
- 1867 Barrett, Charles Albert, M.R.C.S. Edin., L.S.A., &c.
Appleton House, Wallingford, Berks.
- 1874 Bate, George Paddock, M.D., F.R.C.S.E.
2, Northumberland Houses, King Edward's-rd., Hackney, E.
- 1877 Baynes, James, Jr., F.C.S.
Royal Chambers, Scale-lane, Hull.
- 1852 Beale, Lionel Smith, M.B. (Lond.), F.R.C.P., F.R.S., PRESIDENT;
Professor of the Principles and Practice of Medicine in King's College, London, and Physician to the Hospital.
61, Grosvenor-street, W.
- 1859 *Beck, Joseph, F.R.A.S.
31, Cornhill, E.C.
- 1871 Bedwell, Francis Alfred, M.A. (Cantab.).
Fort Hall, Bridlington Quay, Hull.
- 1875 Beeby, William Hadden.
14, Ridinghouse-street, W.
- 1879 Bell, F. Jeffrey, B.A., F.Z.S.; *Professor of Comparative Anatomy in King's College, London.*
5, Radnor-place, Gloucester-square, W.
- 1840 *Bell, Thomas, F.R.S., F.L.S., F.G.S.; *Socc. Hist. Nat. et Philomath. Paris, Acad. Sc. Philad. et Soc. Hist. Nat. Bost. Corresp.*
The Wakes, Selborne, near Alton, Hants.
- 1859 Bennet, James Lindsay.
2, Taviton-street, Gordon-square, W.C.
- 1879 Bennett, Alfred William, M.A., B.Sc., F.L.S.; *Lecturer on Botany at St. Thomas's Hospital.*
6, Park Village East, Regent's-park, N.W.
- 1876 Bentley, Charles Simpson.
Hazelville Villa, Sunnyside-road, Hornsey-rise, N.
- 1866 *Berney, John.
61, North-end, Croydon, Surrey.
- 1870 Berry, John G.
West Riding Bank, Huddersfield.
- 1871 Bevington, William A.
80, Avondale-square, Old Kent-road, S.E.
- 1862 *Bidlake, John Purdue, B.A., F.C.P., F.C.S.
339, Essex-road, Islington, N.
- 1851 Bigg, Henry Heather, Assoc. Inst. C.E.
56, Wimpole-street, Cavendish-square, W.
- 1855 Bishop, George, F.R.A.S., F.R.G.S.
Meadow Bank, Twickenham.
- 1879 Blackham, George E., M.D.
Dunkirk, N.Y., U.S.A.

Elected.

- 1867 Blankley, Frederick.
15, *Belitha-villas, Barnsbury, Islington, N.*
- 1848 Blenkins, George Eliezer, F.R.C.S., F.R.H.S.; *Dep. Insp.-Gen., late Surgeon-Major, Grenadier Guards.*
5, *Sandford-place, Cheltenham.*
- 1877 Bogue, David.
3, *St. Martin's-place, Trafalgar-square, W.C.*
- 1878 Bolton, Thomas.
17, *Ann-street, Birmingham.*
- 1878 Borland, John.
Rosebank, Kilmarnock, N.B.
- 1862 Borradaile, Charles.
East Hoathley, Hawkhurst.
- 1858 *Bossey, Francis, M.D.
Oxford-road, Redhill, Surrey.
- 1865 Bouverie, Right Hon. Edward Pleydell, M.A. (Cantab.), F.R.S.
Manor House, Market Lavington, Wilts.
- 1862 Bowman, Frederick Hungerford, F.R.A.S., F.C.S., &c.
Halifax, Yorkshire.
- 1846 Boyle, William Ansell.
7, *Mecklenburgh-square, W.C.*
- 1855 Bradley, Charles Lawrence, F.R.C.S., F.L.S.
Thatched House Club, St. James'-street, S.W.
- 1854 *Brady, Sir Antonio, Kt., F.G.S., F.M.S., F.A.S.L.
Maryland Point, Stratford, Essex, E.
- 1866 Braidwood, Peter Murray, M.D., L.R.C.S.E.
2, *Delamere-terrace, South Park-road, Birkenhead.*
- 1866 Braithwaite, Robert, M.D., M.R.C.S., F.L.S.
The Ferns, 303, Clapham-road, S.W.
- 1879 *Bramwell, The Right Hon. Sir George William Wilshere.
10, *Hyde-park-square, W.*
- 1879 Bremner, Alexander Martin.
3, *North King's Bench-walk, Temple, E.C.*
- 1876 Brindley, William.
Pergola House, Denmark-hill, S.E.
- 1878 *Brook, George, Ter.
Fernbrook, Huddersfield.
- 1864 *Browne, Rev. Robert Henry Nisbett, M.A. (Oxon.), F.R.B.S.
120, *Inverness-terrace, Bayswater, W.*
- 1861 Browne, Rev. Thomas Henry, F.G.S., M.E.S.
High Wycombe, Bucks.
- 1863 Browning, John, F.R.A.S., F.M.S.
63, *Strand, W.C.*
- 1856 Brownlow, George John, M.A. (Cantab.); *Associate of King's College, London.*
4, *St. Alban's-road, Kensington, W.*
- 1866 Brushfield, Thomas Nadauld, M.D., &c.
County Asylum, Brookwood, Woking, Surrey.
- 1862 Bunting, Frederick.
1, *Westall-place, Cheltenham.*

Electes.

- 1868 *Burn, William Barnett, M.D. (Lond.), M.R.C.S.
Ecclesbourne, Bedford-hill-road, Balham, S.W.
- 1860 Burton, John.
50, Portland-road, Nottingham.
- 1855 Burton, John Moulden, F.R.C.S.
Lee Park Lodge, Lee, S.E.
- 1876 *Butler, Philip John, F.Z.S.
55, De Beauvoir-road, N.
- 1860 *Bywater, Witham Matthew.
5, Hanover-square, W.
- 1879 Campbell, Francis Maule.
Rose Hill, Hoddesdon.
- 1878 Campion Frank.
The Mount, Duffield-road, Derby.
- 1870 *Capel, Charles Cecil.
North Cray-place, Chislehurst, Kent.
- 1874 *Carpenter, Alfred, M.D., J.P.
High-street, Croydon, Surrey.
- 1879 Carpenter, Henry Sanders.
Beckington House, Weigh-ton-road, Anerley, S.E.
- 1848 Carpenter, William Benjamin, C.B., M.D., LL.D., F.R.S., L.S.
and G.S., Hon. F.C.P.S.; *Inst. Fr. (Acad. Sci.), Soc. Biol.,*
Soc. Philomat. Paris, et Soc. Phil. Amer. Philad. Corr. Mem.
56, Regent's-park-road, N.W.
- 1867 Cartwright, Samuel, F.R.C.S.
32, Old Burlington-street, W.
- 1861 *Cattley, Edward Abbs.
Care of Messrs. Ropes & Co., 5, Jeffrey's-square, St. Mary
Axe, E.C.
- 1879 Cazaux, Denis Blancq.
61, Finsbury-park-road, N.
- 1852 Ceely, Robert, F.R.C.S.
Aylesbury.
- 1851 Chamberlain, Thomas.
11, Dacre-road, Forest-hill, S.E.
- 1879 *Chandler, George.
15, Coleman-street, E.C.
- 1867 Chaplin, Richard Piper.
Earlham, Babbicombe-road, Torquay.
- 1863 Ciaccio, Dr. Guiseppe.
Bologna, Italy.
- 1868 Codd, Francis.
51, Duke-street, Devonport.
- 1867 *Codrington, Oliver, M.R.C.S. (Army Medical Department).
Fort Pitt, Chatham, Kent.
- 1879 Cole, Arthur Charles.
St. Domingo House, Oxford-gardens, Notting-hill, W.

Elected.

- 1872 Cole, Walter B.
St. John's-terrace, Weymouth.
- 1866 Collins, Charles.
157, *Great Portland-street, W.*
- 1842 Cooper, William White, F.R.C.S. ; *Surgeon-Oculist in Ordinary to Her Majesty the Queen.*
19, *Berkeley-square, W.*
- 1867 *Coppock, Charles, F.M.S.
109, *Grosvenor-road, Highbury New-park, N.*
- 1875 Cowan, Thomas William.
Compton's Lea, Horsham, Sussex.
- 1870 Crisp, Frank, LL.B., B.A., F.L.S., &c. ; SECRETARY.
5, *Lansdowne-road, Notting-hill, W.*
- 1874 Crisp, John Shalders.
Ashville, Lewin-road, Streatham, S.W.
- 1875 Croft, Lieut. Richard Benyon, R.N.
Ware, Herts.
- 1860 *Crofton, Edward, M.A. (Oxon.).
45, *West Cromwell-road, Earl's Court-road, S.W.*
- 1866 Crook, Thomas.
3, *Grosvenor-villas, Cleveland-road, Surbiton.*
- 1863 Crouch, Henry.
66, *Barbican, E.C.*
- 1871 Croydon, Charles.
Pato Point, Wilcove, Torpoint, Cornwall.
- 1853 Cundell, George Smith.
Clarence Lodge, Clarence-road, Clapham-park, S.W.
- 1878 Cunliffe, Peter G.
The Elms, Handforth, Manchester.
- 1866 Curties, Thomas.
244, *High Holborn, W.C.*
- 1871 Dallinger, Rev. W. H.
The Parsonage, Woolton, near Liverpool.
- 1860 Dallmeyer, John Henry, F.R.A.S.
19, *Bloomsbury-street, W.C.*
- 1866 Davis, Charles.
29, *Gloucester-place, Portman-square, W.*
- 1862 *Davis, George.
Heathlands, Bournemouth.
- 1862 Davis, Henry.
Wingate House, Haigh, Wigan.
- 1878 Davis, John.
56, *Sutherland-gardens, St. Peter's-park, W.*
- 1865 Davison, Thomas.
248, *Bath-street, Glasgow.*
- 1854 *Dayman, Charles Orchard, M.A. (Cantab.), F.R.A.S.
Merric Meade, Millbrook, Southampton.

Elected.

- 1878 Deby, Julien.
72, *Warwick-gardens, Kensington, W.*
- 1863 Do Castro, James Cato.
Care of G. Carew, Esq., 15, Southampton-street, Bloomsbury, W.C.
- 1855 De Grave, John Francis, M.R.C.P. Lond., M.R.C.S.
13, *Morland-road, Croydon.*
- 1846 *De La Rue, Warren, M.A., D.C.L. (Oxon.), Ph.D., F.R.S., F.R.A.S., F.C.S., *Ord. S.S.^{rum}. Maur. et Lazar. Ital. Com., Leg. Imp. Honor. et Ord. Imp. Bras. Rosae Eq., Soc. Photog. Edin. et Soc. pro Phys. indag. Berol. Soc. Honor., Acad. Imp. Sci. Petrop., Soc. Reg. Sci. Upsal., Soc. pro fov. Indust. Nat. et Soc. Philom. Par., Soc. d'Agric. et de Commerce de Caen, et Soc. Sci. Nat. Carob. Mem. Corr.*
73, *Portland-place, W.*
- 1867 Dobson, Henry Holmes.
Holmesdale, Grange-park, Ealing, W.
- 1879 Douglas, John A.
23, *Bentley-street, Bradford.*
- 1868 Draper, Edward Thomson.
12, *Buckingham-street, Strand, W.C., and Haringey-park, Crouch End, N.*
- 1879 Dreyfus, Ludwig.
181, *Adelaide-road, St. John's-wood.*
- 1874 Drysdale, John James, M.D.E.
36a, *Rodney-street, Liverpool.*
- 1879 Duncan, Peter Martin, M.B. (Lond.), F.R.S., F.G.S.; *Professor of Geology in King's College, London, Acad. Nat. Sci. Philad. Corr. Mem.*
4, *St. George's-terrace, Regent's-park-road, N.W.*
- 1868 Durham, Arthur Edward, F.R.C.S., F.L.S., &c.
82, *Brook-street, Grosvenor-square, W.*
- 1853 Dyster, Frederiek Daniel, M.D., F.L.S.
Tenby, Pembrokeshire.
- 1868 Eddy, James Ray, F.G.S.
The Grange, Carleton, near Skipton, Yorkshire.
- 1878 Edmunds, James, M.D.
8, *Grafton-street, Piccadilly, W.*
- 1867 Edmunds, Thomas Wilcox.
32, *Old Change, E.C.*
- 1853 Elliott, William Timbrell.
113, *Adelaide-road, N.W.*
- 1862 Ellis, Septimus.
Bruton House, Woodford, Essex.
- 1860 *Elphinstone, Howard Warburton, M.A. (Cantab.), F.L.S.
2, *Stone-buildings, Lincoln's-inn, W.C.*
- 1861 Emmens, William.
National Bank, Old Broad-street, E.C.

Elected.

- 1867 Evans, Henry Sugden, F.C.S.
Care of Evans & Co., 60, Bartholomew Close, London, E.C.
- 1859 Eve, Richard Wafford, M.B., F.R.A.S.
101, Lewisham High-road, S.E.
- 1864 Fairey, John Wilkinson.
Lovell, Riddlesdown Park, Kenley, Surrey.
- 1840 Farre, Arthur, M.D. (Cantab.), F.R.C.P., F.R.S.; *Physician Extraordinary to the Queen, Physician Accoucheur to H.R.H. the Princess of Wales, and H.R.H. the Duchess of Edinburgh.*
18, Albert Mansions, Victoria street, S.W.
- 1878 Festing, Major Augustus Morton.
6, St. Jean D'Acre-terrace, Devonport.
- 1862 *Finzil, Conrad William.
Frankfort Hall, Clevedon, Somerset.
- 1860 *Firmin, Philip Smith.
Ladbroke, Mortlake-road, Kew.
- 1879 Fischer, Carl F., M.D., F.L.S., F.G.S., *Soc. Zool.-Bot. Vindob. Socius.*
Sydney, N.S. Wales. Care of Gerich & Co., 7, Mincing-lane, E.C.
- 1866 Fitch, Frederick, F.R.G.S.
Hadleigh House, Highbury New-park, N.
- 1866 Fitch, Frederick George.
17, Canonbury-park North, N.
- 1860 FitzGerald, Alexander.
43, Milbank-street, Westminster, S.W.
- 1872 Fowke, Francis.
40, Nottingham-place, W.
- 1861 Fox, Charles James.
26, South Molton-street, Oxford-street, W.
- 1879 Frampton, Capt. Cyril, R.M.
Forton Barracks, Gosport.
- 1876 Freckelton, Rev. Thomas Wesley.
28, Lonsdale-square, Islington, N.
- 1860 Freestone, William Lionel.
63, Navarino-road, Dalston, E.
- 1856 Fuller, William.
Woodcote, Epsom, Surrey.
- 1863 Garnham, John.
123, Bunhill-row, E.C.
- 1866 *Gay, Frederick William.
113, High Holborn, W.C.
- 1862 Gent, John Henry.
79, Great Tower-street, E.C.

Elected.

- 1862 *George, Edward.
70, *Old Broad-street, City, E.C.*, and 12, *Derby-villas, Forest-hill, S.E.*
- 1879 Gibbes, Heneage.
42, *Colville-terrace, Bayswater, W.*
- 1858 *Gibbons, William Sydney.
Melbourne, Australia. Care of C. Hickman, 78, Church-street, Camberwell, S.E.
- 1879 Gibbs, Alban G. H.
82, *Portland-place, W.*
- 1872 Gibson, Joseph F.
Cloceelly, Woodchurch-road, West Hampstead, N.W.
- 1879 Gilbert, William Hewett.
48, *Wetherall-road, South Hackney, E.*
- 1847 Gillett, William Stedman, M.A., F.R.A.S., F.R.H.S., &c.
Harefield, Bittern, Southampton.
- 1856 *Glaisher, James, F.R.S., F.R.A.S., *Pres. Phot. Soc., Ord. Bras. Rosae Eq.*
1, *Dartmouth-place, Blackheath, S.E.*
- 1877 *Godman, Frederick Du Cane, F.L.S.
6, *Tenterden-street, W.*
- 1879 Goodall, Thomas Sorby.
5, *Saint Peter's-street, Derby.*
- 1874 Goodinge, James Wallinger.
18, *Aldersgate-street, E.C.*
- 1867 Gowlland, Peter Yeames, F.R.C.S.; *Surgeon to St. Mark's Hospital.*
34, *Finsbury-square, E.C.*
- 1879 Graham, Walter.
21, *Ludgate-hill, Birmingham.*
- 1866 *Gray, William John, M.D.
41, *Queen Anne-street, Cavendish-square, W.*
- 1861 Green, Edward Baker, F.R.H.S.
3, *Wharf-road, City-road, N.*
- 1870 Greenish, Thomas.
20, *New-street, Dorset-square, W.*
- 1855 Griffith, Richard Clewin, M.R.C.S., F.R.G.S., F.Z.S., F.R.B. and R.H.S., M.R.I.
20, *Gower-street, W.C.*
- 1855 Grove, Edmund.
Saltburn-by-the-Sea, Yorkshire.
- 1879 Groves, J. William; *Demonstrator of Physiology at King's College.*
55, *Russell-square, W.*
- 1872 Guimaraens, A. de Souza.
50, *Lowden-road, Herne-hill, S.E.*
- 1849 *Gurney, Samuel, F.L.S., F.R.G.S., &c.
20, *Hanover-terrace, Regent's-park, N.W.*
- 1861 Guy, William Augustus, M.B. (Cantab.), F.R.C.P., F.R.S.;
Physician to King's College Hospital.
22, *Gordon-street, Gordon-square, W.C.*

Elected.

- 1877 Habirshaw, Frederick.
6, *West 48th-street, New York, U.S.A.*
- 1877 Habirshaw, John, M.D.
6, *West 48th-street, New York, U.S.A.*
- 1875 Hamilton, John James.
South Barrow, Bickley, Kent.
- 1845 Handford, George Charlton.
224, *King's-road, Chelsea, S.W.*
- 1874 †Hanks, Henry.
619, *Montgomery-street, San Francisco, California, U.S.A.*
- 1861 Hardingham, George Gatton, F.R.B.S.
33, *St. George's-square, S.W.*
- 1862 Hardy, Mitchell Charles.
6, *The Terrace, Farquhar-road, Upper Norwood, S.E.*
- 1865 Harkness, William.
Laboratory, Somerset House, W.C.
- 1872 Harris, Edward.
Rydal Villa, Longton-grove, Sydenham, S.E.
- 1878 Harrison, John Simpson.
Care of A. Jubb, Esq., Huddersfield.
- 1868 Harrop, Edward Davy.
Launceston, Tasmania.
- 1867 *Hartree, William, Associate Inst. C.E., F.Z.S.
Carlton-villas, Blackheath-park, S.E.
- 1879 Harvey, Thomas Morton.
89, *Lansdowne-road, Notting-hill, W.*
- 1867 Helm, Henry James.
The Laboratory, Inland Revenue, Somerset House, W.C.
- 1860 Hennell, Colonel Samuel.
Ventnor Villa, Ventnor, Isle of Wight.
- 1879 Hepburn, John Frankland.
7, *Paneras-lane, E.C.*
- 1853 *Hepburn, John Gotch, LL.B. (Lond.), F.C.S.
Baldwyns, Bexley, Kent.
- 1862 Hewitt, Whisson White.
5, *Torriano-gardens, Camden-town, N.W.*
- 1852 Hilton, James.
60, *Montague-square, W.*
- 1855 Hingeston, Charles Hilton.
30, *Wood-street, Cheapside, E.C.*
- 1866 *Hirst, John, jun.
Dobercross, near Manchester.
- 1879 Hitchcock, Romyn.
150, *Nassau-street, New York, U.S.A.*
- 1878 Hobson, Amos.
17, *Regent-street, Waterloo-place, S.W.*
- 1851 Hogg, Jabez, M.R.C.S.
1, *Bedford-square, W.C.*
- 1856 Hopgood, James.
Clapham-common, S.W.

Elected.

- 1867 Hopkinson, John.
Wansford House, Watford.
- 1874 Horne, Robert.
Union-terrace, Cheetham-hill, Manchester.
- 1876 *Hovenden, Charles William.
95, City-road, E.C.
- 1873 *Hovenden, Frederick.
Glenlea, Thurlow-park-road, Dulwich, S.E.
- 1868 Howard, Robert Luke.
Mackerye, Harpenden, St. Albans.
- 1863 Hoyer, Frederick.
Care of Charles Tyler, Esq., 317, Holloway-rd., Holloway, N.
- 1872 Hudson, Charles Thomas, M.A., LL.D. (Cantab.).
Manilla Hall, Clifton, Bristol.
- 1853 Hudson, Robert, F.R.S., L.S., G.S.
Clapham-common, S.W.
- 1864 Hudson, William.
13, Stockwell-street, Greenwich, S.E.
- 1853 Huggins, William, D.C.L. (Oxon.), LL.D. (Cantab. & Edin.),
F.R.S., F.R.A.S., *Math. D. Lugd. Bat., Ord. Imp. Bras.*
Rosac. Com., Inst. Fr. (Acad. Sci.), Acad. Lync. Romae et Soc.
Reg. Sci. Gött. Mem. Corr., Soc. Reg. Sci. Hafn., Physiogr.
Lund., Reg. Boie. Marob., Reg. Dubl. et Lit. Phil. Manc.
Soc. Honor.
Upper Tulse-hill, S.W.
- 1861 Hughes, Rev. John Gwynne.
Maldon, Essex.
- 1867 Humphrys, John James Hamilton.
5, New-square, Lincoln's-inn, W.C.
- 1863 Hunt, William Henry Brooks.
23, Eversholt-street, Oakley-square, N.W.
- 1867 Ibbetson, George Augustus, F.R.C.S., F.G.S.
19a, Hanover-square, W.
- 1867 *Ince, Joseph, F.L.S., G.S., C.S., &c.
29, St. Stephen's-avenue, Shepherd's-bush, W.
- 1840 *Ince, William Henry, F.L.S.
Burleigh House, Baron's Court-road, West Kensington, S.W.
- 1867 Ingpen, John Edmund.
7, The Hill, Putney, S.W.
- 1872 Jackson, B. Daydon, F.L.S.
30, Stockwell-road, S.W.
- 1875 Jackson, Charles Ioxton.
Hill Fold, Sharples, Bolton.
- 1862 Jaques, Edward, B.A.
Office of Woods, &c., 1, Whitehall-place, S.W.
- 1868 Jayaker, Atmaram Sadashwa, L.R.C.P. London.
Muscat, Arabia.

- Elected.
- 1859 *Jeula, Henry, F.R.G.S., F.A.S.L., &c.
West Combe Lodge, Blackheath, S.E.
- 1874 Johnson, Arthur Jukes, M.D.
Corner of William and Young-street, Yorkville, Toronto, Canada.
- 1872 *Johnson, David.
Grosvenor-road, Wrexham.
- 1877 Johnson, Matthew Hawkins, F.R.G.S.
379, Euston-road, N.W.
- 1867 Jones, Arthur O'Brien, F.R.C.S.
The Shrubbery, Epsom, Surrey.
- 1861 *Jones, Emanuel Wilkins, F.R.A.S.
53, Cowley-road, North Brixton, S.W.
- 1877 Jones, George Horatio.
57, Great Russell-street, Bloomsbury, W.C.
- 1875 Jones, Henry Williams.
183, Park-road, Aston, near Birmingham.
- 1875 Jones, Joseph Birdsall.
The Athenæum, Liverpool.
- 1877 Jones, William Henry.
37, Mincing-lane, E.C., and 2, Rye-hill-park, Peckham Rye, S.E.
- 1863 Jordan, John.
6, Notting-hill-square, W., and 3, Victoria-street, S.W.
- 1879 Joshua, William, F.L.S.
Cirencester.
- 1860 Kelly, George.
9, Sutherland-gardens, Kilburn-road, N.W.
- 1873 Kemp, Robert.
60, Windsor-road, Upper Holloway, N.
- 1867 Kent, William Savill, F.L.S., F.Z.S.
46, Osnaburgh-street, Regent's-park, N.W.
- 1867 Kerr, Walter.
316, Fulham-road, S.W.
- 1851 Kershaw, William Wayland, M.D.
10, Claremont-crescent, Surbiton, Surrey.
- 1867 King, Edwin Holborow Green, M.R.C.S., L.D.S.
Killcott, Godalming, Surrey.
- 1872 King, Robert.
Fern House, Upper Clapton.
- 1877 Kingsbury, Francis John.
11, Loughborough-park-road, Brixton, S.W.
- 1840 *Kippist, Richard, A.L.S.; Acad. Nat. Sc. Philad. Corresp.
Linnean Society, Burlington House, W.
- 1879 Kirby, Arthur Raymond.
11a, New-square, Lincoln's-inn, W.C.
- 1879 Knight, Thomas Edward Wilmot.
44, Essex-street, Strand, W.C.

Elected.

- 1878 Kyngdon, Francis Boughton.
221, *Darlinghurst-road, Sydney, N.S. Wales.*
- 1851 Ladd, William, F.R.A.S.
12, *Beak-street, Regent-street, W.*
- 1851 Ladds, John.
8, *Kent-gardens, Castle Hill Park, Ealing, W.*
- 1877 *Lambert, Charles Joseph.
29, *Park-lane, W.*
- 1874 Lancaster, William James, F.R.A.S., &c.
Stanley Villa, Church Hill-road, Handsworth, Birmingham.
- 1861 Lang, Major Frederick Henry.
St. Katherine's, Parkstone, Dorset.
- 1865 Lankester, Edwin Ray, M.A. (Oxon.), F.R.S.; *Prof. of Zoology and Comparative Anatomy in University College, London.*
11, *Wellington Mansions, North Bank, N.W.*
- 1864 Lawson, Marmaduke Alexander, M.A., F.L.S.; *Professor of Botany in the University of Oxford.*
Botanic-gardens, Oxford.
- 1855 *Leaf, Charles John, F.L.S., F.S.A., F.R.G.S.
Old Change, E.C.
- 1842 Lealand, Peter Henry.
170, *Euston-road, Euston-square, N.W.*
- 1874 Leather, Samuel Petty, C.E.
Gas Works, Burnley, Lancashire.
- 1864 *Lee, Henry, F.L.S., F.G.S., F.Z.S.
The Waldrons, Croydon.
- 1876 Lettsom, William Garrow.
2, *Thurlow-place, Lower Norwood, S.E.*
- 1866 *Lewis, Richard Thomas.
1, *Lowndes-terrace, Knightsbridge, S.W.*
- 1871 Lindsay, James Ludovic, Lord, F.R.S., P.R.A.S.
47, *Brook-street, W., and Dun Echt, Aberdeen.*
- 1866 Lovibond, Joseph Williams.
St. Anne-street, Salisbury.
- 1867 Loy, William Thomas.
11, *Garrick-chambers, Garrick-street, Covent-garden, W.C.*
- 1854 *Lubbock, Sir John, Bart., M.P., F.R.S., F.L.S., F.G.S., *Trust.*
Brit. Mus., &c.
High Elms, Bromley, Kent.
- 1879 Lucas, Charles.
St. Thomas's Hospital, S.W.
- 1879 Lyon, Thomas Glover.
85, *Asylum-road, Peckham, S.E.*
- 1861 Mackrell, John.
3, *Victoria-road, Clapham-common, S.W.*

- Elected.
- 1848 Makins, George Hogarth, M.R.C.S., F.C.S.
Danesfield, Walton-on-Thames.
- 1879 Makins, Walter K.
Westhorpe House, Hendon, N.W.
- 1867 McIntire, Samuel John.
22, Bessborough-gardens, Pimlico, S.W.
- 1859 *Manchester, William Drogo, Duke of, F.Z.S.
1, Great Stanhope-street, Mayfair, W., and Kimbolton Castle, St. Neot's, Herts.
- 1875 Manners, George.
1, Lansdowne-gardens, Croydon, Surrey.
- 1867 *Manning, William.
21, Redcliffe-gardens, South Kensington, S.W.
- 1873 Martin, Nicholas Henry.
29, Mosley-street, Newcastle-on-Tyne.
- 1879 Maskell, William Miles, J.P.
Christchurch, Canterbury, New Zealand.
- 1878 *Mason, Philip Brookes.
Burton-on-Trent.
- 1872 Matthews, John, M.D.
30, Colebrooke-row, Islington, N.
- 1857 May, John William, Consul General for the Netherlands.
Arundel House, Percy-cross, Fulham-road, S.W.
- 1867 Mayall, John, jun.
224, Regent-street, W.
- 1866 Mayall, John Edwin, F.A.S.L.
The Stork's Nest, Lancing, Sussex.
- 1856 Meade, The Hon. Robert Henry, F.R.G.S.
Foreign Office, and 32, Belgrave-square, S.W.
- 1879 Mercer, A. Clifford, M.D.
33, Richmond-terrace, Clapham-road, S.W.
- 1850 Mestayer, Richard, F.L.S.
7, Buckland-crescent, Belsize-park, N.W.
- 1877 Michael, Albert Davidson, F.L.S.
3 & 4, Great Winchester-street, E.C.
- 1857 Millar, John, L.R.C.P. Edin., F.L.S., and G.S.
Bethnall House, Cambridge-road, E.
- 1876 Mills, Rev. Lewis George, LL.D.
The Rectory, Creggan, Crossmaglen, Armagh, Ireland.
- 1866 Moginie, William.
26, Lichfield-grove, Finchley, N.
- 1857 *Moore, Joseph.
Rydal Mount, Champion-hill, Cumberwell, S.E.
- 1851 Moreland, Richard, jun., M.I.C.E.
3, Old-street, St. Luke's, E.C., and 4, The Quadrant, Highbury.
- 1865 *Morrison, Colonel Robert.
Oriental Club, Hanover-square, W.
- 1878 Morris, John, F.Z.S.
13, Park-street, Grosvenor-square, W.

Elected.

- 1876 Morris, William, M.D.
*Sydney, New South Wales. Care of J. B. Watt & Co.,
5, East India-avenue, E.*
- 1871 Mostyn, Charles.
Elmley House, Grove-road, Surbiton, S.W.
- 1850 Mummery, John Rigden, F.L.S.
10, Cavendish-place, Cavendish-square, W.
- 1879 Nachet, A.
17, Rue St. Severin, Paris.
- 1879 Nichols, George Livesey.
54, Old Broad-street, E.C.
- 1849 Noble, John, F.R.H.S.
*50, Westbourne-terrace, Hyde-park, W., and Park-place,
Henley-on-Thames.*
- 1855 *Noble, Captain William, F.R.A.S.
Forest Lodge, Maresfield, Sussex.
- 1867 *Oakley, John Jeffryes.
24, Sussex-gardens, Hyde-park, W.
- 1878 O'Hara, Richard, Lieut.-Col.
West Lodge, Galway.
- 1879 Ord, William Millar, M.D., F.R.C.P.
7, Brook-street, Grosvenor-square, W.
- 1856 Osborne, The Hon. and Rev. The Lord Sidney Godolphin, M.A.
Sidmouth.
- 1876 Osler, William, M.D.; *Institute of Medicine, McGill's College,
Montreal. Care of Messrs. Williams & Norgate, 14,
Henrietta-street, Covent-garden, W.C.*
- 1840 Owen, Richard, C.B., M.D., D.C.L., LL.D., F.R.S., F.L.S.,
F.G.S., F.Z.S., *Director of the Natural-History Department,
British Museum, Coll. Reg. Chir. Hib. et Soc. Reg. Edin.
Soc. Honor., Ord. Boruss. "Pour le Merite" Eq., Inst. Fr.
(Acad. Sci.) Par. Adsoc. Extr., Acadd. Imp. Sci. Vindob.,
Petrop., et Soc. Imp. Sc. Nat. Hist. Mosq., Acadd. Reg.
Sci. Berol., Taurin., Madrit., Holm., Monach., Neapol.,
Bruxell., Bonon., Instit. Reg. Sc. Amstelod., Soc. Reg. Sc.
Hafn., Upsal., Acad. Amer. Sc. Bost. Socius, Soc. Philomath.
Paris. Corresp., Geor. Florent., Soc. Sc. Harlem., Trajectin.,
Phys. et Hist. Nat. Genev., Acadd. Lync. Romæ, Patav.,
Panorm., Gioen. Nat. Scrutat. Berol., Instit. Wetter., Philad.,
Nov.-Ebor., Bost., Acad. Reg. Med. Paris., Soc. Imp. et Reg.
Med. Vindob. Adsoc. Extr.
*British Museum, W.C., and Sheen Lodge, Mortlake, S.W.**

Elected.

- 1865 *Owen, Major Samuel Richard John.
Care of J. F. Collingwood, Esq., Anthropological Institution, 4, St. Martin's-lane, W.C.
- 1879 Oxley, Frederick.
8, Crosby-square, E.C.
- 1846 Page, Julius, F.R.A.S.
63, South-street, Greenwich, S.E.
- 1873 Palmer, Thomas, B.Sc.
Homeleigh, Lower Camden, Chislehurst.
- 1879 Parker, T. Jeffery, B.Sc.
Sproxtton, Brodrick-road, Upper Tooting, S.W.
- 1853 Parker, William Kitchen, F.R.S., F.L.S., F.Z.S., *King's Coll. Lond. et Phil. Soc. Cantab. Soc. Honor., Acad. Sci. Nat. Philad. Soc. Corr.*
36, Claverton-street, S.W.
- 1861 Parkinson, William Coulson.
18, Carleton-road, Tufnell-park West, N.
- 1862 Paton, George Lauchland.
34, Richmond-terrace, Clapham-road, S.W.
- 1867 Pearse, George Edmund Legge, M.R.C.S.
Markham House, King's-road, Chelsea, S.W.
- 1866 *Peck, Sir Henry William, Bart., M.P., &c.
Wimbledon House, S.W.
- 1852 *Perigal, Henry, F.R.A.S.
9, North-crescent, Bedford-square, W.C.
- 1853 *Peters, William, F.R.A.S., F.R.B.S., F.Z.S.
Ashfold, Crawley, Sussex.
- 1866 *Pickersgill, William Cunliffe, F.R.H.S.
Blendon Hall, Bexley, Kent.
- 1861 Pidgeon, Daniel.
Winchester House, 30, Cheyne-walk, Chelsea, S.W.
- 1857 Piggot, Joseph Allen.
Bedford.
- 1855 Pillischer, Moritz.
88, New Bond-street, W.
- 1854 Pitchford, Edward Beaumont.
Varnish Works, Egham, Surrey.
- 1864 Pittock, George Mayris, M.B. (Lond.).
23, Cecil-square, Margate.
- 1879 Plomer, George Daniel.
48, Springfield-road, St. John's-wood, N.W.
- 1879 Pochin, Percival Gerard.
Grove House, Tottenham.
- 1875 Pocklington, Henry.
Cedar-grove, Armley, Leeds.
- 1867 Potter, George.
42, Grove-road, Upper Holloway, N.

Elected.

- 1840 Powell, Hugh.
170, *Euston-road, Euston-square, N.W.*
- 1867 *Prescott, Sir George Rendlesham, Bart., F.Z.S.
Isenhurst, Hawkhurst, Sussex.
- 1878 Price, George Peters, jun.
Tandridge House, The Avenue, Elmers, Surbiton.
- 1840 Pritchard, Rev. Charles, M.A. (Cantab.), F.R.S., F.R.A.S., F.G.S.,
F.C.P.S., Savilian Professor of Astronomy, Oxford.
9, Keble-terrace, Oxford.
- 1879 Pritchard, Urban, M.D.
4, George-street, Hanover-square, W.
- 1851 Prothero, Thomas, F.S.A., F.R.B.S., &c.
16, Cleveland-gardens, Bayswater, W.
- 1879 *Puleston, John Henry, M.P.
Westminster Palace Hotel, S.W.
- 1868 Puttick, Alfred James.
26, King-street, Covent-garden, W.C.
- 1874 Radford, William, M.D.
Sidmouth.
- 1868 *Ramsden, Hildebrand, M.A. (Cantab.), F.L.S.
Forest Rise, Walthamstow, Essex, N.E.
- 1878 Raynor, George.
78, Great Clowes-street, Lower Broughton, Manchester.
- 1852 Read, Rev. William, M.A., F.R.A.S.
Worthing.
- 1862 Reade, George.
Fern-hill, Whitby.
- 1877 Redmayne, John Thomas, L.R.C.P. Edin., M.R.C.S. Edin.
Astley Bank, Bolton.
- 1869 Redpath, Henry Syme.
Sydenham, S.E.
- 1864 Reeves, Walter Waters, ASSISTANT-SECRETARY.
30, Ashburnham-grove, Greenwich, S.E.
- 1861 *Richards, Edward.
289, Camberwell New-road, S.E.
- 1875 Roberts, Samuel Hackett.
33, King-street, Cheapside, E.C.
- 1871 Rogers, John.
4, Tennyson-street, Nottingham.
- 1873 Rogers, Thomas.
Selmeston, Thurlow-park-road, West Dulwich, S.E.
- 1867 *Rogerson, John.
- 1871 Roper, Charles, M.R.C.S., &c.
7, Chichester-place, Southernhay, Exeter.
- 1852 *Roper, Freeman Clark Samuel, F.L.S., G.S., Z.S.
Palgrave House, Eastbourne, Sussex.

Elected.

- 1877 Roper, Henry John.
5, *Lausanne-road, Peckham, S.E.*
- 1856 Rothery, Henry Cadogan, M.A. (Cantab.), F.L.S., M.R.S.L.,
M.R.I.
94, *Gloucester-terrace, Hyde-park, W.*
- 1863 Royston-Pigott, George West, M.A., M.D. (Cantab.), Coll. Reg.
Med. Soc., F.C.P.S., F.R.S.
Hartley Court, Reading, Berks.
- 1879 Ruffle, George William.
131, *Blackfriars-road, S.E.*
- 1866 *Rumble, Thomas William, C.E., Assoc. Inst. Naval Architects.
Vauxhall Water Company, Sumner-street, Southwark, S.E.
- 1862 *Rylands, Thomas Glazebrook, F.L.S., F.G.S., F.R.A.S.
Highfields, Thelwall, near Warrington.
- 1873 Salkeld, Lieut.-Colonel Joseph Carleton.
29, *St. James'-street, S.W.*
- 1863 *Sanders, Alfred, M.R.C.S., F.L.S., F.Z.S.
2, *Clarence-place, Gravesend, Kent.*
- 1866 *Saunders, Charles.
Airy-hill, Whitby.
- 1879 Sawyer, George D.
55, *Buckingham-place, Brighton.*
- 1877 Schlesinger, Henry.
5, *Kensington-park-gardens, W.*
- 1845 Shadbolt, George.
Beechcroft, Camden-park, Chislehurst, Kent.
- 1857 Sharpe, George Young.
34, *High-street, Notting-hill, W.*
- 1867 Shephard, Thomas.
Kingsley Lodge, Chester.
- 1854 Shuter, James Legasick, F.R.A.S.
33, *Farringdon-street.*
- 1871 Sigsworth, John Cretney.
18, *Chaucer-road, Herne-hill, S.E.*
- 1859 *Silver, Hugh Adams, Assoc. Inst. C.E.
Hillside, Chislehurst, Kent.
- 1860 Simpson, Charles Turner.
14, *Cornwall-gardens, South Kensington, S.W.*
- 1866 Simpson, Rev. David, M.A. (Cantab.).
45, *Rue Malesherbes, Lyons, France.*
- 1862 Slack, Henry James, F.G.S.
Ashdown Cottage, Forest-row, Sussex.
- 1877 Sleeman, Rev. Philip R.
Richmond-hill, Clifton, Bristol.
- 1878 Smart, John Naish.
3, *Brunswick-place, Swansea.*

Elected.

- 1864 *Smith, Basil Woodd, F.R.A.S.
Branch Hill Lodge, Hampstead-heath, N.W.
- 1859 Smith, James, F.L.S.
233, Dalston-lane, Hackney, E.
- 1866 *Smith, Joseph Travers, F.R.B.S.
4, Raymond's-buildings, Gray's-inn, W.C.
- 1874 Smith, Rowland Dunn, M.R.C.S. Edin.
1, Clapton-square, E.
- 1866 *Sorby, Henry Clifton, LL.D., F.R.S., P.G.S., F.L.S., F.Z.S.,
Soc. Min. Petrop., Soc. Holland. Harl. Socius., Acad. Sci. Nat.
Philad. et Lyc. Nat. Nov. Ebor. Corr. Mem.
Broomfield, Sheffield.
- 1864 *Spawforth, Joseph.
Sandall Cottage, Hornsey-rise, N.
- 1877 Spencer, James.
South-street, Greenwich, S.E.
- 1857 Spencer, Thomas, F.C.S.
32, Euston-square, N.W.
- 1879 Spicer, Robert Henry Scanes, B.Sc.
14, Sydney-street, S.W.
- 1854 Spurrell, Flaxman, L.R.C.P. Edin., F.R.C.S., &c.
Belvedere, Kent, S.E.
- 1861 Stephenson, John Ware, F.R.A.S., TREASURER.
186, Clapham-road, S.W.
- 1860 Steward, James Henry.
406, Strand, W.C.
- 1876 Stewart, Charles, M.R.C.S., F.L.S., SECRETARY.
25, Albert-square, Clapham-road, S.W., and St. Thomas's
Hospital, S.E.
- 1867 Stoker, George Naylor.
The Laboratory, Inland Revenue Office, Somerset House, W.C.
- 1854 *Streatfield, John Fremlyn, F.R.C.S.
15, Upper Brook-street, W.
- 1871 Stuart, John.
164, New Bond-street, W.
- 1879 Stabbins, John, F.G.S.
Chester Cottage, Old-lane, Halifax.
- 1863 *Suffolk, William Thomas.
Stettin Lodge, St. Faith's-road, Lower Norwood, S.E.
- 1850 Symonds, Frederick, F.R.C.S., F.M.S.
35, Beaumont-street, Oxford.
- 1870 *Tebbitt, Walter.
Elmhurst, Cavendish-road, Clapham-park, S.W.
- 1840 Tennant, James, F.G.S., C.S., M.S., Z.S.; *Fellow of the Geo-*
graphical Society of France, Professor of Mineralogy at
King's College, London.
149, Strand, W.C.

Elected.

- 1848 Terry, William, F.R.H.S., F.Z.S.
Peterborough House, Fulham, S.W.
- 1858 *Thompson, Frederick, F.A.S.L.
South-parade, Wakefield.
- 1840 Tingle, Thomas, F.L.S.
Apothecaries' Hall, Blackfriars, E.C.
- 1879 Tolles, Robert B.
48, Hanover-street, Boston, U.S.
- 1854 Townley, James, L.R.C.P. Edin., F.R.C.S., F.L.S.
302, Kennington-park-road, S.E.
- 1871 *Townsend, John Sumsion.
Stamford Lodge, St. John's, Sevenoaks, Kent.
- 1852 Truman, Edwin, M.R.C.S.; *Dentist to Her Majesty's Household.*
23, Old Burlington-street, W.
- 1877 Tulk, John Augustus, M.A. (Cantab.), M.R.C.P. Lond.
Burton Lodge, Staines-road, Twickenham.
- 1861 Tupholme, John Thomas.
1, Coleherne-terrace, West Brompton.
- 1879 Turner, William Barwell, F.C.S.
55, Reginald-terrace, Chapeltown-road, Leeds.
- 1863 Tyer, Edward, C.E., F.R.A.S., F.R.G.S., Assoc. Inst. C.E.
32, Russell-square, W.C.
- 1858 *Tyler, Charles, F.L.S., F.G.S.
317, Holloway-road, Holloway, N.
- 1862 *Tyler, George, F.R.G.S.
317, Holloway-road, Holloway, N.
- 1863 *Tyler, Sir James, F.L.S., F.Z.S., F.R.B. and R.H.S.
Pine House, Holloway, N.
- 1862 *Tyler, Rev. William.
247, Hackney-road, N.E.
- 1860 *Vanner, William.
Camden-wood, Chislehurst, Kent.
- 1840 *Van Voorst, John, F.L.S., F.Z.S.
1, Paternoster-row, E.C.
- 1879 Vezey, John Jewell.
39, St. Donatt's-road, New Cross, S.E.
- 1863 *Vicary, William, F.G.S., F.M.S.
The Priory, Colleton-crescent, Exeter.
- 1857 Vinen, Edward Hart, M.D., M.R.C.S., F.L.S.
17, Chepstow-villas, Bayswater, W.
- 1879 Vize, Rev. John Edward, M.A.; *Hon. Mem. Woolhope Naturalists' Field Club, Hon. Corr. Mem. Cryptogamic Society of Scotland.*
Forden Vicarage, Welshpool.
- 1860 Wain, Thomas.
13, Warwick-street, Regent-street, W., and Shrublands, Hersham, Esher, Surrey.

Elected.

- 1863 Walker, Frederick.
Heywood, Tenby.
- 1867 Walters, James Hopkins, M.R.C.S.
43, Castle-street, Reading.
- 1869 Ward, Frederic Henry, M.R.C.S.
Springfield, near Tooting, S.W.
- 1877 Ward, Rev. James Clifton, F.G.S.
Keswick, Cumberland.
- 1862 Ward, John Whitely.
South Royde, Halifax, Yorkshire.
- 1879 Watson, Thomas E.
2, Clifton-place, Newport, Mon.
- 1878 Watts, Rev. G. E., M.A.
Kingsworth Vicarage, Dunstable, Herts.
- 1872 Webb, Henry Richard, J.P.
Epeira, Lyttelton, Canterbury, New Zealand.
- 1861 Wells, John Robinson, M.D., F.R.C.S.
20, Fitzroy-street, Fitzroy-square, W.
- 1852 West, Tuffen, F.L.S.
Frensham, near Farnham, Surrey.
- 1840 Westley, William.
24, Regent-street, S.W.
- 1861 Westwood, William Henry.
Oatlands-park, Weybridge, Surrey.
- 1864 Wheeler, Edmund, F.R.A.S.
48, Tollington-road, Holloway, N.
- 1868 Wheldon, John.
58, Great Queen-street, Lincoln's-inn-fields, W.C.
- 1850 White, Charles Frederick.
42, Windsor-road, Ealing, W.
- 1867 White, Robert Owen, M.I.C.E.
The Priory, Lewisham, S.E.
- 1867 White, Thomas Charters, M.R.C.S., L.D.S.
32, Belgrave-road, S.W.
- 1867 Whitelock, Rev. Benjamin, M.A. (Cantab.).
Lealands, Groombridge (Sussex), near Tunbridge Wells.
- 1866 *Whitling, Henry Townsend, M.R.C.S.
53, High-street, Croydon, Surrey.
- 1879 Whittell, Horatio Thomas.
Edgbaston House, Adelaide, South Australia.
- 1866 Wight, James Ford.
Grazeley, Gipsy-hill, Upper Norwood, S.E.
- 1879 Williams, George.
1, Devonport-road, Shepherd's-bush, W.
- 1874 Williams, John Railton.
59, Albion-road, Stoke Newington, N.
- 1879 Willmott, Collis.
Triangle, Hackney, E.
- 1857 Wilson, Richard, M.R.I.
80, Old Broad-street, E.C.

Elected.

- 1879 Wilson, Samuel King, M.R.I.
3, *Portland-terrace, Regent's-park, N.W.*
- 1857 Wiltshire, Rev. Thomas, M.A., F.L.S., F.G.S.
25, *Granville-park, Lewisham, S.E.*
- 1861 Winstone, Benjamin.
53, *Russell-square, W.C.*
- 1842 Wood, Frederick, F.R.C.S.
13, *Marine-square, Brighton.*
- 1879 Woodall, Robert.
1, *Marlbro-terrace, Maple-road, Penge, S.E.*
- 1850 *Woodhouse, Alfred James, L.D.S.
1, *Hanover-square, W.*
- 1878 Woods, George Arthur, L.R.C.P., M.R.C.S., &c.
57, *Houghton-street, Southport.*
- 1859 Yool, Henry, F.Z.S.
Oakfield, Weybridge, Surrey.
- 1879 Zeiss, Carl.
Jena, Germany.
-

Elected.

HONORARY FELLOWS.

- 1878 Abbe, E.
Jena.
- 1879 Agassiz, A.
Cambridge (Mass.), U.S.
- 1879 Archer, W.
Dublin.
- 1879 Balbiani, E. G.
Paris.
- 1879 Bary, A. de.
Strassburg.
- 1879 Beneden, P. J. van.
Louvain.
- 1879 Berkeley, Rev. M. J.
Sibbertoft, Market Harborough.
- 1869 Busk, G.
London.
- 1879 Bütschli, O.
Heidelberg.
- 1876 Castracane, Conte Ab. F.
Fano (Italy).
- 1879 Cienkowski, L.
Kharkoff.
- 1879 Cleve, P. T.
Upsala.
- 1879 Cohn, F.
Breslau.
- 1879 Cornu, M.
Paris.
- 1879 Dodel-Port, A.
Zürich.
- 1879 Engelmann, T. W.
Utrecht.
- 1879 Frey, H.
Zürich.
- 1851 Gray, Asa.
Cambridge (Mass.), U.S.
- 1879 Grunow, A.
Berndorf, near Vienna.
- 1870 Hankey, J.
New York, U.S.
- 1879 Harting, P.
Utrecht.
- 1876 Kitton, F.
Norwich.
- 1879 Kölliker, A. v.
Würzburg.
- 1879 Leidy, J.
Philadelphia, U.S.

Elected.	
1871	Maddox, R. L. <i>London.</i>
1879	Metschnikoff, E. <i>Odessa.</i>
1879	Nägeli, C. <i>Munich.</i>
1879	Nylander, W. <i>Paris.</i>
1879	Oudemans, C. A. J. A. <i>Amsterdam.</i>
1879	Pasteur, L. <i>Paris.</i>
1879	Ranvier, L. <i>Paris.</i>
1877	Renard, A. <i>Louvain.</i>
1879	Sars, G. O. <i>Christiania.</i>
1879	Schleiden, M. J. <i>Wiesbaden.</i>
1879	Schulze, F. E. <i>Graz.</i>
1879	Schwann, T. <i>Liège.</i>
1879	Schwendener, S. <i>Berlin.</i>
1879	Smith, Hamilton L. <i>Geneva (N.Y.), U.S.</i>
1879	Steenstrup, J. J. S. <i>Copenhagen.</i>
1879	Stein, F. Ritter von <i>Prague.</i>
1879	Strasburger, E. <i>Jena.</i>
1879	Thümen, F. de <i>Vienna.</i>
1879	Tieghem, Ph. van <i>Paris.</i>
1872	Wallich, G. C. <i>London.</i>
1879	Warming, E. <i>Copenhagen.</i>
1879	Waterhouse, G. R. <i>London.</i>
1879	Weismann, A. <i>Freiburg i. Br.</i>
1875	Woodward, J. J. <i>Washington (D. C.), U.S.</i>
1879	Zittel, K. A. <i>Munich.</i>

SOCIETIES WHOSE PRESIDENTS FOR THE TIME BEING ARE

EX-OFFICIO FELLOWS.

(ELECTED 1879.)

UNITED KINGDOM.

London—

Quekett Microscopical Club
South London Microscopical and Natural History Club

Provinces—

Birmingham Natural History and Microscopical Society
Brighton and Sussex Natural History Society
Bristol Microscopical Society
Bristol Naturalists' Society
(Canterbury.) East Kent Natural History Society
Cardiff Naturalists' Society
Croydon Microscopical and Natural History Club
Eastbourne Natural History Society
Leeds Philosophical and Literary Society
Liverpool, Literary and Philosophical Society of
Liverpool, Microscopical Society of
(Norwich.) Norfolk and Norwich Naturalists' Society
(Newcastle-upon-Tyne.) North of England Microscopical
Society
Plymouth Institution and Devon and Cornwall Natural History
Society

Scotland—

Glasgow, Natural History Society of
(Perth.) Cryptogamic Society of Scotland
(") Perthshire Society of Natural Science

Ireland—

Dublin Microscopical Club
Belfast Natural History and Philosophical Society

COLONIES.**India—**

(Calcutta.) Asiatic Society of Bengal

Australasia—

New South Wales, Linnean Society of

New South Wales, Royal Society of

(South Australia.) Philosophical Society of Adelaide

Tasmania, Royal Society of

Victoria, Royal Society of

Victoria, Microscopical Society of

(New Zealand.) Wellington Philosophical Society

Canada—

(Halifax.) Nova Scotian Institute of Natural Science

Montreal, Natural History Society of

(Toronto.) Canadian Institute

UNITED STATES.

(Boston.) American Academy of Arts and Sciences

(„) Boston Society of Natural History

(Chicago.) State Microscopical Society of Illinois

New York Academy of Sciences

New York Microscopical Society

Philadelphia, Academy of Natural Sciences of

St. Louis, Academy of Sciences of

San Francisco Microscopical Society

Troy Scientific Association

GERMANY.

Berlin, K. Preussische Akademie der Wissenschaften zu

Berlin, Gesellschaft Naturforschender Freunde in

(Dresden.) K. Leopoldinisch-Carolinische Deutsche Akademie
der Naturforscher

(Frankfurt a. M.) Senckenbergische Naturforschende Gesell-
schaft

(Frankfurt a. M.) Deutsche Malakozoologische Gesellschaft

Göttingen, K. Gesellschaft der Wissenschaften zu

Jenaische Gesellschaft für Medicin und Naturwissenschaft

(Leipzig.) K. Sächsische Gesellschaft der Wissenschaften

(München.) K. Bayerische Akademie der Wissenschaften

AUSTRIA-HUNGARY.

(Vienna.) K. Akademie der Wissenschaften

(„) K.K. Zoologisch-botanische Gesellschaft in Wien

(Prag.) K. Böhmisches Gesellschaft der Wissenschaften

(Budapest.) Hungarian Academy

HOLLAND.

(Amsterdam.) K. Akademie van Wetenschappen

Haarlem, Hollandsche Maatschappij der Wetenschappen te

(Société Hollandaise des Sciences à Harlem)

DENMARK.

(Kjöbenhavn.) K. Danske Videnskabernes Selskab

SWEDEN.

(Stockholm.) K. Svenska Vetenskaps Akademien

RUSSIA.

Moscou, Société Impériale des Naturalistes de
(Odessa.) Société des Naturalistes de la Nouvelle Russie
St. Petersbourg, Académie Impériale des Sciences de

SWITZERLAND.

Basel, Naturforschende Gesellschaft in
Genève, Société de Physique et d'Histoire Naturelle de
(Lausanne.) Société Vaudoise des Sciences Naturelles
(Zürich.) Allgemeine Schweizerische Gesellschaft für die
Gesamten Naturwissenschaften (Société Helvétique des
Sciences Naturelles)

FRANCE.

(Amiens.) Société Linnéenne du Nord de la France
Bordeaux, Société des Sciences Physiques et Naturelles de
Lyons, Société Linnéenne de
Marseille, Académie des Sciences, Belles-Lettres et Arts de
Montpellier, Académie des Sciences et Lettres de
(Paris.) Académie des Sciences
(„) Société Botanique de France
(„) Société Cryptogamique de France

BELGIUM.

(Brussels.) Académie Royale des Sciences, des Lettres et des
Beaux-Arts de Belgique
(„) Société Belge de Microscopie
(„) Société Malacologique de Belgique
(„) Société Royale de Botanique de Belgique

ITALY.

(Florence). Società Malacologica Italiana
Milano, Istituto Lombardo di Scienze e Lettere di
(Milano.) Società Crittogamologica Italiana
(Pisa.) Società Toscana di Scienze Naturali
Torino, R. Accademia delle Scienze di
(Venezia.) R. Istituto Veneto di Scienze, Lettere ed Arti
(Roma.) R. Accademia dei Lincei

SPAIN.

(Madrid.) Sociedad Española de Historia Natural

PORTUGAL.

Lisboa, Academia Real das Sciencias de

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FEBRUARY, 1879.

[Price 3s.

JOURNAL
OF THE
ROYAL
MICROSCOPICAL SOCIETY;
CONTAINING ITS
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WITH OTHER
MICROSCOPICAL AND BIOLOGICAL INFORMATION.

Edited, under the direction of the Publication Committee, by
FRANK CRISP, LL.B., B.A., F.L.S.,
ONE OF THE SECRETARIES OF THE SOCIETY.



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1879.

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VOL. II. No. 1.

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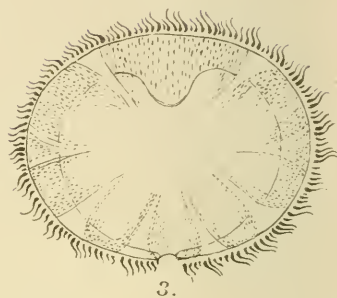
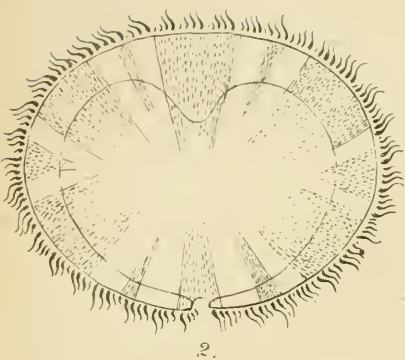
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" April 9.	" November 12.
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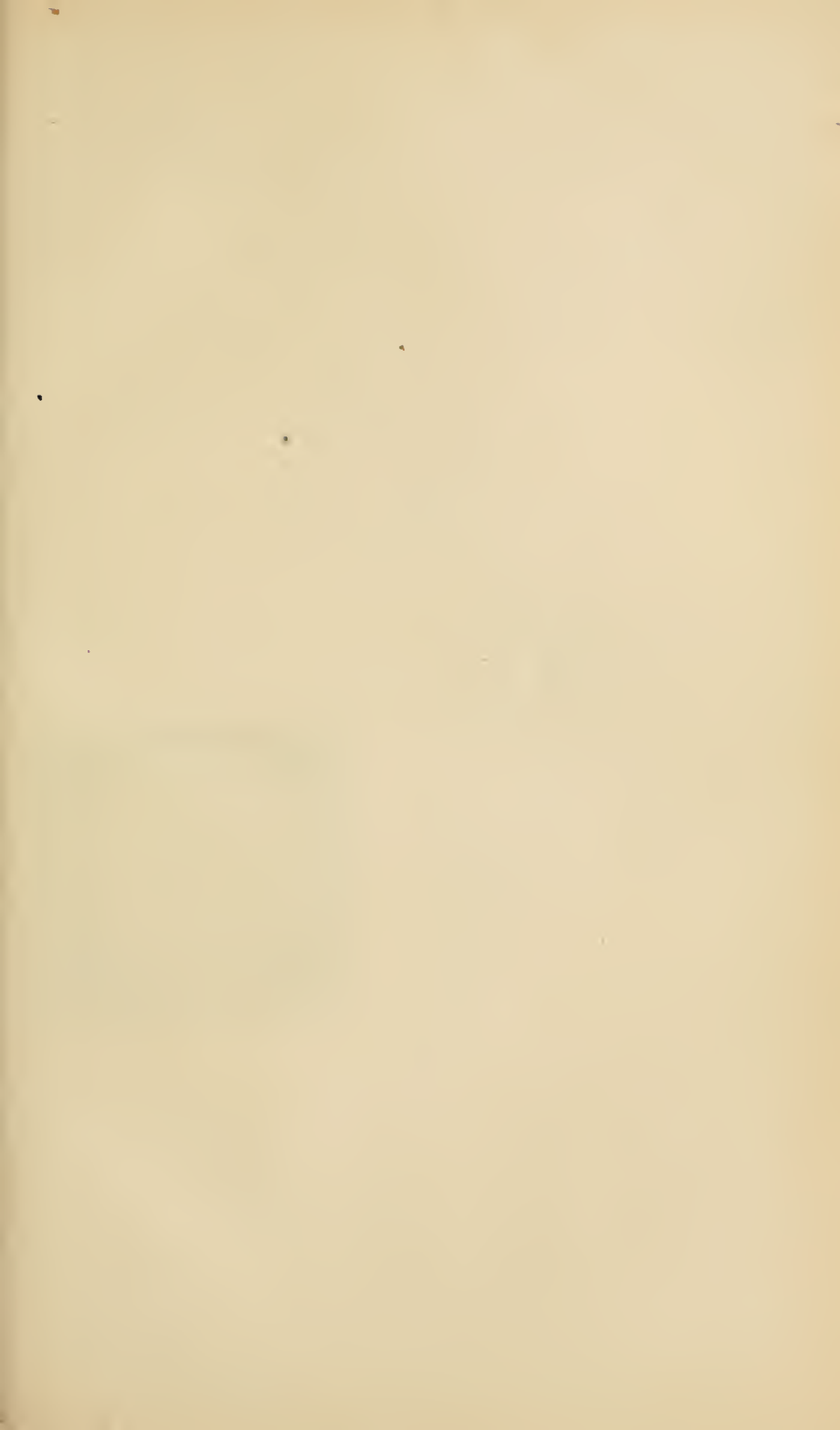
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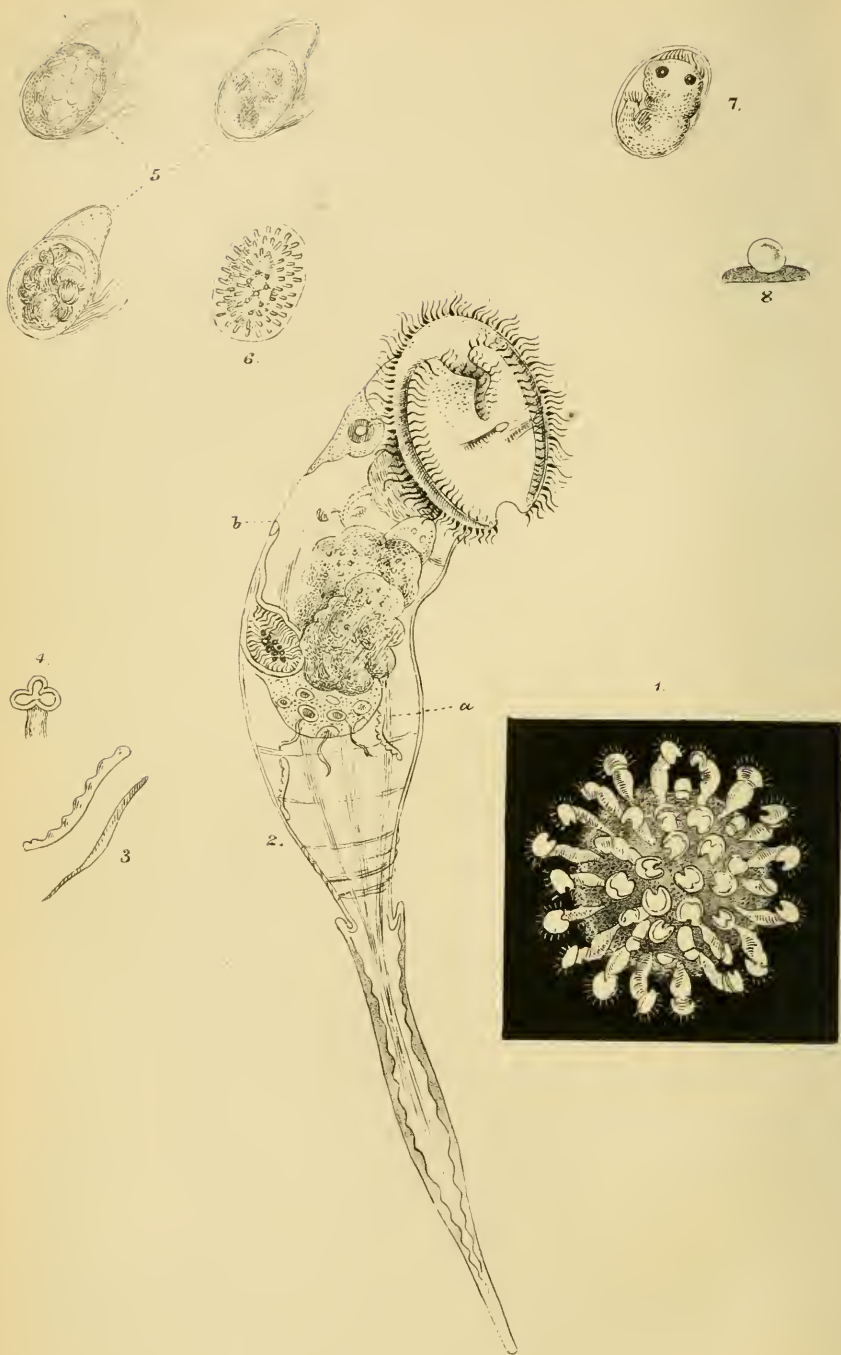


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HENRY CROUCH, 66, Barbican, London, E.C.







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OF THE
ROYAL MICROSCOPICAL SOCIETY.
FEBRUARY, 1879.

TRANSACTIONS OF THE SOCIETY.

I.—On *Æcistes umbella* and other Rotifers.

By C. T. HUDSON, M.A., LL.D., V.P.R.M.S.

(Read 11th December, 1878.)

PLATES I. AND II.

THIS remarkable new species was discovered by Mr. F. Oxley last June in a pond at Snaresbrook. Mr. Oxley was so kind as to send me several specimens, but I was unfortunately prevented from giving them all the attention they so well deserved; and though I made some sketches of this *Æcistes*, I was unable to investigate its structure and habits in the way that I should have wished to do.

It is a large handsome species, and the specimens sent to me had made their clay-coloured fluffy homes on the leaves and in the axils of a sphagnum. The tubes, if I may call such loose structures by so precise a name, resemble those of the rotifer I described as *Melicerta tyro*; but which I think had better be

EXPLANATION OF THE PLATES.

PLATE I.

Æcistes umbella.

- FIG. 1.—A group of three.
„ 2.—Disk of *Æ. umbella*.
„ 3.—Disk of *Æ. crystallinus*.

PLATE II.

Conochilus volvox.

- FIG. 1.—A cluster.
„ 2.—An individual. *a*, spermatozoa on ovary; *b*, extremity of anus.
„ 3.—Spermatozoa (two forms).
„ 4.—Extremity of anus.
„ 5.—Winter egg in ovary (various stages).
„ 6.—Winter egg (final stage).
„ 7.—Male in egg.
„ 8.—Eye.

named *Melicerta tubicolaria*; as I have now little doubt, in spite of the errors in his figures and description, that this was the rotifer out of which Ehrenberg framed his genus *Tubicolaria*.

Nothing can be more irregular than the shapes of the homes in which these creatures dwell. They are fluffy masses of a substance secreted by the animal itself, and fortified by random gatherings of material thrown down on them by the action of the ciliary disk. Like those of all the tube-making rotifers, they have only a small cylindrical passage down their centre, up and down which the animal moves, and the material of which they are composed is continuous from the rotifer right out to the surface. By transmitted light they appear to be *hollow*; but this is not the case, and the dark-field illumination will generally enable the observer to trace the delicate material everywhere from the outer surface to the animal within. In *Floscularia campanulata* I have seen the young newly-hatched male bore his way with his long cilia from the side of his mother right out of her case; and I have also seen it die in the attempt. The most remarkable thing about *Æcistes umbella* is its disk, which is so strengthened by ribs across it in various directions, that it looks somewhat like an odd kind of umbrella. Two of these thickenings are very broad, and run across, as shown in the figure, from the ventral to the dorsal side of the disk. When the rotifer closes its disk, it naturally folds it so as to bring these stouter portions together, the thinner parts being folded within them; and, in consequence, it often has an odd square look about its head, that I have never seen in any other species of *Æcistes*. But this strengthening of the disk is not peculiar to it. The common *Æcistes crystallinus* has precisely the same thing, only on a much smaller scale (as may be seen in the Plate, Fig. 3), and similar thickenings are visible in *Æ. pilula*.

In *Æ. umbella* there is on either side of the disk a branched rib like a gusset; but the whole structure must be viewed in various directions and by different modes of illumination to get a clear idea of it. The central ribs, when the disk is viewed edge-ways, are clearly seen to project above its surface a little.

My friend Mr. A. W. Wills found this rotifer in one of the ponds of Sutton Park, and exhibited some specimens in October at a meeting of the Birmingham Natural History Society. Mr. Wills has figured and described it in the December number of the 'Midland Naturalist,' adding to his interesting remarks some accurate measurements of a full-grown individual. From these it will be seen that *Æ. umbella* is much larger than *Æ. crystallinus*, and about twice as large as *Æ. pilula*. On a piece of alga which Mr. Wills has just sent me, the two species can be seen side by side, and form a very pretty picture. They have been living in Mr. Wills' tank, and have come to me in excellent condition in

spite of the severe weather, which seems to have killed all their brethren in the ponds.

Æ. umbella has two well-marked red eyes which can be seen on looking down through the disk; they are situated well within the animal, below the disk, and towards the dorsal side, that is, towards the side where the mouth is not.

Ehrenberg's family, *Æcistina*, ought of course to be included in the family of the *Melicertans*, but I agree with Mr. Wills that the genus *Æcistes* ought to be retained, as we have now no less than five species; viz. *Æ. crystallinus*; Mr. Davis' new pair, *Æ. intermedius* and *Æ. longicornis*; Mr. Tatem's *Æ. pilula*; and Mr. Oxley's *Æ. umbella*.

Conochilus volvox.—I had the pleasure of reading Mr. Davis' excellent paper on this most curious rotifer,* just after I had been drawing it from a few specimens which had survived the transit from London to Clifton. The creature is a bad traveller, not a single sphere remained unbroken; and indeed the tube contained no group with more than four rotifers in the cluster. In some respects this was an advantage, as it enabled me to see much more clearly than I otherwise should have done the animal's structure. First let me say that Mr. Davis' account of this rotifer is most accurate. He is quite right in pointing out that there are the usual pair of setæ-bearing antennæ, one on either side of the mouth, not *four* conical papillæ, each with a bristle, as Ehrenberg asserts. He correctly states that the line of cilia is interrupted in one part of the disk, and that the notch in the cilia is *not* where the mouth is. Mr. Davis has also most clearly shown the peculiarity of this rotifer's structure in having its mouth and anal aperture on the same side: and in its fringe of large cilia enclosing that of the small cilia as well as the mouth; instead of its being enclosed by the smaller cilia, and of the mouth's lying between the two fringes. Mr. F. A. Bedwell has given an admirable and most forcible illustration of the difference between the trochal disk of *Conochilus* and that of *Melicerta* in his capital paper on the building apparatus of *Melicerta ringens*.

The arrangement of the parts is so curious in *Conochilus*, and so exasperating to a classifier, that I may venture to suggest even a third way of considering them. If a crochet hook were supposed to be pushed through the centre of the disk, down the middle line of the body, and hooked on to the end of the foot, then on drawing the hook right back again, the animal would be turned inside out like the inverted finger of a glove, and be pulled through its own disk; and the relative position of its organs would be nearly that of an ordinary *Melicertan*. In the drawing that I have given of a *Conochilus*, it will be seen that the anal aperture lies remarkably

* 'M. M. J.,' vol. xvi. p. 1.

high on the back, and that it has a curious trefoil opening. In one of the specimens I could distinctly see several spermatozoa attached to the ovary and still moving. The spermatozoa were of two shapes—or at all events along with the usual spindle-like forms were others like a curved cord with a puckered ribbon sewn all down it. Both these forms can be readily seen in the sperm sacs of the males, and both are constantly in motion. How the spermatozoa got outside of the ovary I cannot imagine—and that some were outside I am certain. The ovary, I believe, opens into the anus, and I know of no way in which the spermatozoa could escape into the perivisceral cavity.

There is a point of resemblance between *Conochilus* and the *Floscules* which is well worth notice. From the mastax to the mouth the alimentary canal is strengthened in an unusual way by a tube much harder than the surrounding parts. In *Floscularia campanulata* the tube hangs down from the mouth, and is constantly thrown into long slow undulations. As it is transparent, its edges only can be usually brought into focus, so that it looks like two waving lines or like the edges of two flat membranes, and thus it has been described. Under favourable circumstances, however, food or water may be seen to dilate it as it passes down, and I have repeatedly seen this happen in such a way as to make it obvious that the structure is really a tube. On crushing *F. campanulata* or *Conochilus volvox*, the tube will be found to remain, and even to resist the action of caustic potash along with the harder portions of the mastax.

Notommata aurita.—A few months ago I found this rotifer in great abundance in a pond near Bath. The water was swarming at the same time with free *Vorticellæ* of a fine dark green, speckled with brown. The bottle that I carried home with me had a very large number of these restless creatures in it, and I found them very much in my way as I was examining the *Notommata*, for they constantly knocked up against the rotifers, and made them withdraw the curious earlike appendages from which they derive their name, and which I was anxious to see. One thing puzzled me very much, and that was the rapid disappearance of the *Vorticellæ* from the bottle. The surface of the water was alive with them when I brought them home, and next morning there were not a fourth of the number to be seen. Almost all the *Notommata*, too, were useless for purposes of observation, for they were gorged with green food, so that their stomachs hid the other organs. The exact similarity of tint between the contents of the *Vorticellæ* and the stomachs of the *Notommata* had already struck my attention, when I thought I saw a rotifer (unluckily on the opposite side of a bit of horn-wort) holding one of the *Vorticellæ*. Could it be possible that these *Notommata* could eat the *Vorticellæ*? I put a large

piece of the weed, in which several specimens of both creatures were entangled, under the Microscope, and with a low power watched eagerly to see if I could catch the rotifer in the fact. After a few minutes' observation, I was inclined to reject the idea as absurd.

The Vorticellæ rushed backwards and forwards, knocked fearlessly against the rotifers, and, while evidently frightening the latter, took no sort of pains to get out of their way; in fact, behaved, as to me they always *do* seem to behave, just like animated machines. As to the slow-swimming and still slower crawling rotifer catching one of these swift rovers, the thing seemed impossible. Under any circumstances, whether swimming or crawling, whenever the Vorticella struck the Notommata, the latter either drew in his wheels, and ignominiously rolled over and over to the bottom, or if it were crawling on a bit of the weed it shrunk back, and contracted itself with every appearance of alarm.

Still there were two ugly facts unaccounted for, viz. the disappearance of the Vorticellæ, and the appearance in the stomachs of the Notommata of substance marvellously like them. I was just going to try to imprison a Notommata in a coil of cotton with one or two of the Vorticellæ, when I noticed one of the latter caught in the angle between two small stems of horn-wort. A Notommata, too, was crawling along one of the stems in its usual slow fashion. There was a chance that the sluggish creeper might get to the angle before the Vorticella darted off again on its travels. Fortune favoured me; the Vorticella kept waltzing round and round in the same spot, and the Notommata crawled on till it all but touched the Vorticella. I hoped to see the rotifer quicken its pace, or make—I will not say a *dart*, that would be too much, but at all events a *lurch* at its prey; imagine my chagrin when I saw it coolly curl round the stem and begin to retrace its steps, actually freeing the Vorticella from its prison by brushing it with its back as it crawled back again. There had not been a thousandth of an inch separating the rotifer's head from the Vorticella, and yet, in spite of its two eyes, it had not noticed it. Again, I thought of bringing in a verdict of "not guilty"; but another good look at dark green stomachs revived all my suspicions, and once more I patiently waited till another Vorticella, possibly the same, repeated its silly performance of getting into a corner and dancing there till some one should set it free. This time it was freed only too effectually. The Notommata once more crawled down to the captive, "without hurry or care," and struck its nose (if I may use the expression) against the Vorticella, just as if it were by accident. But the instant it did so it jerked up its head, and snapped at and seized its victim with its sharp jaws; and in a second I saw the whole contents of the Vorticella pouring down

the throat into the stomach of the rotifer. Guilty!—and without appeal.

There are a few observations showing that the rotifers occasionally use their maxillæ as teeth, but only a few. Mr. Gosse mentions the snapping action of those of *Synchaeta mordax*. Mr. Slack saw a *Diglena* chase, seize with its jaws, and shake an anguillula that had presumed to jostle it. I have frequently seen *Hydatina senta* protrude its maxillæ, and snatch at some tempting green globule that the cilia could not quite force down the mouth; and once I saw a small *Notommata* deliberately snip the side of the cell of an alga, and suck out its green contents. On this occasion I contrived to see the catching of Vorticellæ by *Notommata* several times, and in each case the Vorticella was seized by the rotifer's maxillæ and its contents so completely appropriated that it was hardly possible to see the delicate film that was left after the operation had taken place.

Melicerta ringens.—Mr. F. A. Bedwell has given a most interesting and suggestive account of the building apparatus of this rotifer, in the November number of the 'Monthly Microscopical Journal' for 1877.* His description of the various currents which pass round and through this apparatus is admirable. To one point alone do I feel inclined to take any exception, and that is, to the separation of the particles into "four deflected streams" by the action of a sensitive cushion above the mastax. I quite agree with Mr. Bedwell that a first selection among the particles whirled round the groove of the disk is made by "two knotty protuberances set symmetrically one against the other" just at the ends of the collecting groove, and directly opposite to the chin; and that from these the main stream of waste material is directed in a great rush over the chin. But I think that the very feeble currents which creep along (as Mr. Bedwell has so well described) under the curved edges of his "hopper" admit at least of another explanation. If *Melicerta ringens* is fed with carmine, and the chin and its appendages steadily watched, it will be seen that on either side of the swift main stream which carries the waste particles over the chin, runs a feeble current between it and (if I may use the term) the bank; running, in fact, as already said, under the curved edges of Mr. Bedwell's "hopper," and along what Mr. Cubitt calls the "chases." In these currents are gently carried along such minute particles as are fitted to form the pellet, and they pass over the two notches at the chin into the pellet cup. About these facts I think there can be no doubt. It is the *modus operandi* only that is in question. It is of course possible that the sensitive cushion described by Mr. Bedwell may, like a skilful batsman, strike the larger particles into the centre of the stream, and the smaller ones to the sides where

* 'M. M. J.,' vol. xviii. p. 214.

the "chases" are; but I am inclined to think that the effects witnessed are rather due to the friction between the sides of the "hopper" and the stream itself. Anyone who has sat in a boat floating down a swift stream must have noticed that light floating particles on the surface pass him, that they are going at a quicker rate than his boat is; and that anything like a free buoy, which in still water would float upright, is in the swift stream tilted *forward* as it floats, its submerged end as it were dragging behind the free top. All this is clearly due to the fact that the upper portions of the river are flowing faster than the lower, which are hindered by the friction of the water against the channel itself. In the same way the side portions of the stream close to the banks move perceptibly slower than those farther off, and very much slower than the centre of the stream. The result is that while the heavier floating bodies, owing to their greater momentum, generally escape from the feeble currents if they ever get into them, the very light particles (often pushed aside and towards the banks by the heavier ones) are constantly caught and retained by the gentle currents at the side. I think then that the minute particles pass slowly along the "chases," merely because along the chases run comparatively feeble currents, owing to the retarding action of the sides of the "hopper," and especially of its curved edges.

I should be inclined to think also that the production of the peculiar form of the pellet is due to mechanical considerations out of *Melicerta's* control. For instance, the pellet is frequently seen to rotate in one direction round its axis, and then after a few revolutions to rotate in the opposite direction round the same axis; and to repeat this again and again with great regularity, the coloured specks on the pellet even enabling the observer to *time* the process. Now at first sight this looks as if *Melicerta* had reversed the action of its cilia in the cup at its own pleasure; but I believe that there is a simpler explanation. The cilia with which the cup is lined, suddenly curving inwards in turn one after another—just as on the trochal disk—produce a vortex in one constant direction so long as the pellet is small enough to lie clear of all of them, but when it gets larger it hinders the action now of one portion of the cilia lining the pellet, now of another, by getting so close to them as to stop their blows, and then the cilia on the opposite side to the checked ones have the advantage and produce a current towards themselves, which not only makes the pellet rotate round its axis *from* the checked ones *towards themselves*, but at last draws it bodily over to the side where the cilia are free, thus checking in their turn those previously free and releasing those previously checked. Of course, the rotation is at once reversed till the pellet is drawn back to its old position, and then *da capo*. That the pellet is not truly spherical is, I think, mainly

due to the fact that it is made in a cup into which material slowly trickles at the edge. The greater portion of such material, when the pellet has reached a certain size, would be whirled on to it before reaching the bottom of the cup — and the nearer any portion of the pellet was to the bottom, the less its chance of getting fresh accretions. Hence, in the main, arises its subconical shape. Such a shape would be readily thrown by the motions of *Melicerta* out of its first position, in which its longer axis is at right angles to the lower portion of the cup, into a new position in which that axis lies across the cup; and once in this position it would not be very easy to get out of it. The action of the cilia on it in this new position would now obviously tend to make it rotate round its longer axis, as those cilia opposite to the extremities of that axis would have their action checked by the pellet itself. Moreover, the fresh material would *now* tend to be mainly arranged round the pointed end, as it would be only those cilia which were on either side of it that would have perfectly free action; those opposite the larger end being constantly checked by the pellet's touching them. This would finally lead to a roughly cylindrical pellet of the usual form.

But I am afraid that I have already pursued the subject too far for the reader's patience; I will only say, in conclusion, that I heartily sympathize with Mr. Bedwell's appreciation of the wonders of this living atom. Whatever may be the correct explanation of the facts he so lucidly describes (and I am by no means confident that my own is the correct one), the facts themselves remain a perpetual source of wonder and delight to all who, like himself, not only possess a Microscope, but are able to use it.

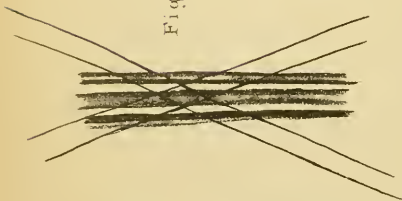


Fig. 1

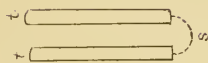


Fig. 5.



Fig. 2

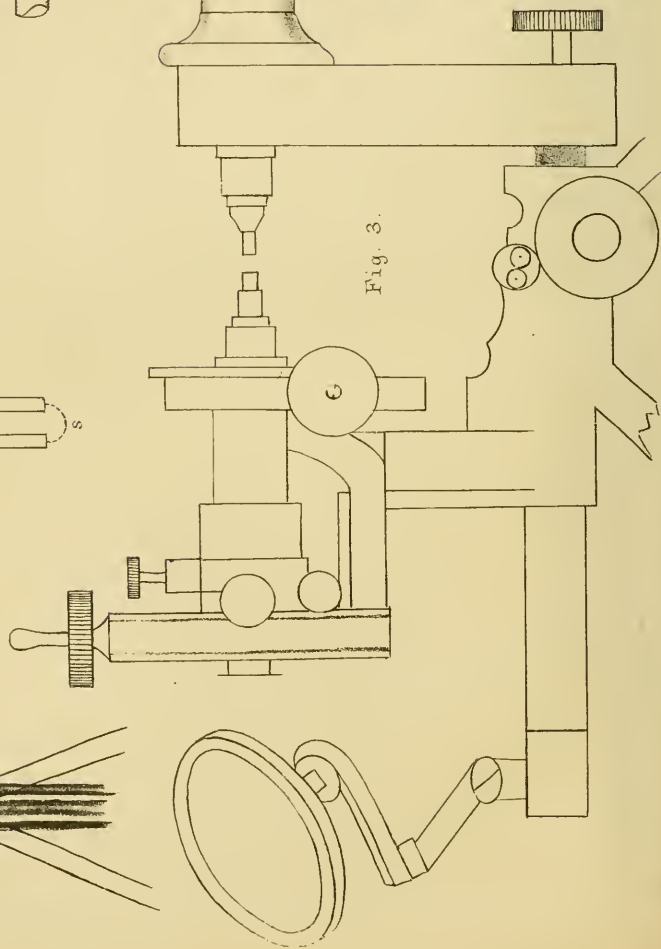


Fig. 3.

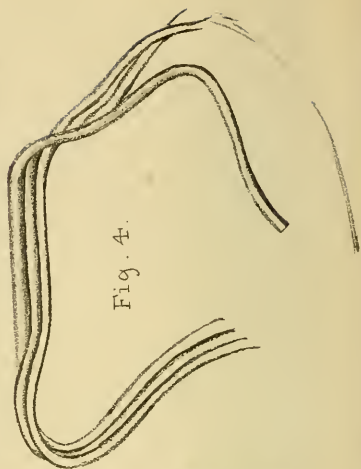


Fig. 4.

II.—*A Further Inquiry into the Limits of Microscopic Vision and the delusive application of Fraunhofer's Optical Law of Vision.*

No. II.

By Dr. ROYSTON-PIGOTT, M.A., F.R.S., &c.

(Read 13th November, 1878.)

PLATE III.

THE writer has been more particularly led into the present subject by the wide-spread belief that the limit of microscopic vision has been reached by the resolution of Nobert's lines drawn at the rate of 112,000 per inch, which probably gives the 1-200,000th for the diameter of the smallest line supposed to be visible. It will not be uninteresting to relate the history of this belief.

The celebrated Fraunhofer (as stated in his Memoir to the Bavarian Academy of Sciences, June 14, 1823) succeeded in ruling lines as close as 30,000 to the Paris inch, which he found totally invisible with the Microscope. He also announced that if λ be the wave-length, and the light fell perpendicularly to the surface of the ruled glass, $\sin \theta^{(n)}$ would become imaginary, and therefore the lines would produce no coloured spectra; and he concluded, says Sir John Herschel, "that an object of less linear magnitude than λ can in consequence never be discerned by Microscopes as consisting of parts." *

The skilful optician Nobert, believing in this result obtained by Fraunhofer, utterly despaired that anyone would ever succeed in describing his finest lines on glass.†

Now with regard to this very conclusion of Fraunhofer, Sir John Herschel regards it as "one which would put a natural limit to the magnifying power of Microscopes, but "which," says he, "we cannot regard as following from the premises" (*sic*).‡

Well, Dr. Woodward first achieved the honour of resolving these lines with a Powell and Lealand $\frac{1}{16}$ immersion in 1869;§ and in consequence of the grave doubts expressed by their maker, he wrote to Dr. Barnard, a distinguished mathematician (Pres. Columbia College), who replied that "with an objective that takes

* Art. "Light," 'Encyc. Met.,' p. 490.

† Nobert thus wrote to Dr. Colonel Woodward, U.S., dated Barth, Feb. 26, 1869. He expressed his belief that the resolution of the higher bands is an impossibility when light is permitted to fall on closely ruled lines. "The formula," says he, " $\sin. x = \frac{\lambda}{b}$ (Fraunhofer's), if by λ we designate the length

of the undulations, by b the distance between two lines of the grating, and by x the angle of the refracted rays, gives for $\sin. x$ an impossible value when b becomes less than λ ;" that is to say, when the distance between two lines is less than a wave-length, the lines will become invisible.

‡ 'Encyc. Met.' art. "Light," p. 490.

§ See 'Month. Mic. Jour.,' Dec. 1869, quoted by Dr. Woodward.

in a cone of an angle of from 140° to 175° it is nonsense to talk of this question as settled by theory. We shall continue to see closer lines just in proportion as Microscopes and modes of illumination are improved.”*

That has long been the firm opinion of the writer. In the first paper on the subject of the limits of vision, he stated, “I believe this limit has not yet been reached;”† and farther on, p. 181, “With special adaptations to subdue or destroy the brilliant diffractions of too bright an illumination, many minute details before completely effaced may be brought into distinct revelation.” When these remarks were made, the microscopical world had been recently favoured with the beautiful formula introduced independently, I believe, by Professors Helmholtz and Abbe, in which further elucidation of the principle was given by a new formula including the semi-angle of aperture of the objective used. Applying these similar results, I obtained, for mean rays of wave-length, $\frac{1}{46182}$ of an inch (46,000th nearly) the following results:—

A TABLE OF PROPORTIONATE RESOLVING POWERS ‡ (some of the details of which were as follows):—

Full Aperture of Object-glass.	Proportionate Resolving Power.	Semi-aperture.
179°	$\sin. \alpha = 99996$ per inch	$89\frac{1}{2}^\circ$
175°	$\sin. \alpha = 99905$ „	$87\frac{1}{2}^\circ$
150°	$\sin. \alpha = 96590$ „	„
120°	$\sin. \alpha = 86600$ „	60°
$12^\circ 38'$	$\sin. \alpha = 11000$ „	$6^\circ 19'$

I hope to show in the following paper that however truly this optical law may be deduced from the premisses, it utterly fails for minute dark lines.

An announcement that it is possible to descry with microscopic apparatus the millionth of an inch would be almost too startling to believe. The human eye can distinguish a hair under favourable conditions of light and background subtending an angle of even less than a second. The black line dividing close double stars, such as χ Ursæ Majoris, which are both of the same (fourth) magnitude, does not subtend in the telescope with a power of 300 diameters many seconds of arc. Besides this, the Microscope differs only from the telescope in the length of its focus and smaller aperture, which, according to received dogma, gives great advantages of vision to the instrument with so great an angular aperture. We cannot doubt, either, from the tales of travellers, that birds of prey possess exceedingly acute vision, by which they can descry small objects at a

* See ‘Month. Mic. Jour.,’ Dec. 1869, quoted by Dr. Woodward.

† P. 175, ‘M. M. Jour.,’ Oct. 1876.

‡ P. 181, *ibid.*

great distance. I myself knew a friend who could see with the naked eye Jupiter's satellites, and dot down their position though ignorant of astronomy. If a simple organ of sight can distinguish such objects as subtend only a second or two, it would seem strange that modern glasses can only show objects presenting many seconds to the eye at the last visual image formed in the eye-piece.

In the following observations I shall endeavour to substantiate a fact apparently irreconcilable with the results of the now famous formula.*

In point of fact, the opinion has now become established both in Europe and America, that Nobert's lines 112,000 per inch (or lines of that size) are the closest that can be seen; and that the law enunciated in the footnote forbids the hope of farther advance in minute definition.

Now, considering the readiness with which a fine horsehair can be distinguished against a light cloudy sky, as also spider lines at several feet distance, I determined to mount upon glass several spider threads and measure their diameter by means of Browning's spider-line recording micrometer. After many trials, I found the smallest of these measured 1-35000th in diameter (Fig. 4).

I measured them by means of Powell and Lealand's magnificent $\frac{1}{3}$ dry lens. On this spider thread I could perceive irregularities, nodules, and marks; but the general thickness was remarkably true. Some others measured $\frac{1}{160000}$, $\frac{1}{180000}$, and coarse agglomerations, cord-like, were as thick as fine spun glass $\frac{1}{30000}$ th.

It then occurred to me to make a novel use of the "Aerial Micro-meter" formerly described by me, consisting of the "Browning" inverted beneath the sub-stage, as also placed in a reversed position (see Fig. 3).

The law established contains two remarkable elements: the kind of light, i.e. the length of the wave, and the aperture of the objective. For blue light (wave $\lambda = 53000$ per inch) intermediate between blue and indigo, this, with an aperture of 150° , would give

$$\text{Extreme limit of } \left. \begin{array}{l} \text{visibility} \end{array} \right\} \epsilon = \frac{1}{2 \sin. 75^\circ} = \frac{1}{53000 \times 2 \times .960}, \text{ nearly} = \frac{1}{102000}.$$

* This is thus stated:—

If ϵ represent the smallest interspace recognizable between two bright lines or disks, on the condition that the diffraction fringe of one does not overlap that of its neighbour; and

If λ be the length of the wave of light under consideration, which for mean rays equals $\frac{1}{18182}$ of an inch; and

If α be the semi-aperture of the objective,

$$\epsilon = \frac{\lambda}{2 \sin. \alpha} = \frac{\lambda}{2} \text{ (when aperture} = 180^\circ),$$

and

$$= 1-96590\text{th (when aperture} = 150^\circ).$$

So that with the more favourable blue ray the smallest interval visible among contiguous bright disks or lines is about one hundred thousandth of an inch, and that only with the largest aperture. Such is the belief disseminated.

About ten years ago I requested Messrs. Beck to make for me an "iris diaphragm" with "adapters" on each side. By this ingenious contrivance, screwed between an objective and the body, the angular aperture could be instantly reduced at will.

It seems, on the face of it, not a little surprising, considering this famous optical law, that the visibility of lines of great minuteness is very little affected by great reduction of objective aperture, by means of this instrument, or by using low-angled objectives of sufficient power and excellence of manufacture. Apparently this is another failure of the celebrated law, as roundly stated and generally received.

It will be convenient to explain here two practical points:—

A.—*The method used in finding the diameter of the spider lines enclosed within the micrometer.*

B.—*The method employed in measuring the absolute reduction of the object in miniature.*

A.—The Rev. Mr. Dallinger has given us his beautiful measurements of the flagella in monads, by drawing an equivalent line with a very hard fine pencil on white paper, by means of the *camera lucida*. By this process he, after a great many observations, determined its diameter to be less than the two hundred thousandth of an inch.

The plan I adopted was by finding divisions on glass placed in the focus of the eye-piece which appeared perfectly coincident in diameter with the observed spider line; and then substituting a scale of a hundred thousandth of a metre, a most careful measurement was made of the apparent size of the diamond cut. The process was much facilitated by altering the length of the draw tube, and changing the objective until the most acceptable result was arrived at. I am indebted to Mr. Beck for the use of an exquisite scale of this kind, as also for the loan of $\frac{1}{20}$ th objectives, dry and immersion, which latter has reduced the miniature to the extraordinary minuteness and precision of definition, at seven inches, of one hundred and forty times less than the object.

On examining spider threads, gathered after recent spinning, with Powell and Lealand's best $\frac{1}{8}$ dry, and measuring them with the spider-line micrometer inserted in the body, I was charmed with perceiving the characteristic brilliant central band, due to a minute cylindrical lens of great beauty, and perfection of definition: and searching for threads lying flat and in close contact, I found some consisted of four cylinders in contact, showing four bright

bands running longitudinally. Taking a pair of these, the cross wires of the micrometer were accurately adjusted in the centre of each bright space, the result for this order of spider was (making the power 1000) with the micrometer

$$\frac{6.7}{10000} = \frac{1}{15000} \text{th very nearly (see Fig. 1).}$$

Different spiders spin much thinner webs, and seem to unite several according to the tension required. Another fibre measured $\frac{1}{17000}$, and some are discoverable $\frac{1}{33000}$ th. See Plate III.

B.—The reduction by miniature will be readily understood from diagrams, shown Fig. 3. There are two ways of deciding the ratio of reduction: the one by examining the size of the miniature itself, the other by finding the magnifying power of the apparatus used as a Microscope.

For this purpose it was especially mounted on the arm of the Microscope used to carry the body (exhibited to the meeting).

In these ways it was found that:—

Immersion $\frac{1}{8}$	Powell and Lealand, miniaturd	36.7 times	at $4\frac{1}{4}$ inches.
„ $\frac{1}{16}$	b. Gundlach	„ 50.17	„ $4\frac{1}{2}$ „
„ $\frac{1}{20}$	R. and J. Beck	„ 140	„ 7 „

The distance between object and spider lines in the focus of the positive eye-pieces varied accidentally with the length of the objective mount itself. But the “Beck glass” required seven inches to do it justice, and also to get the miniature sufficiently reduced. It was easy to form the image at any desirable distance, but then the mirror could not be used very well beyond seven inches, nor the micrometer held sufficiently steady without complex arrangements. The one shown is simple and adequate.

The miniature can, it is evident, be carried to any extent; which, however, is limited to certain dimensions depending upon two important conditions—brilliance or darkness. A very brilliant line or disk is enlarged considerably, whilst a dark line is little changed.

If you miniature the sun’s disk by viewing an aerial image of it formed by a 3-inch lens (100” distant), employing a magnificent $\frac{1}{10}$ immersion, you will get a disk reduced 1000 times theoretically; and since $\frac{1}{38.2}$ of an inch is the diameter of the image of the sun formed by the 3-inch lens, its diameter miniaturd on the stage is 1000 times less, or

$$\frac{1}{382000} = \frac{4}{100000} * \text{ nearly.}$$

* See ‘Proc. Roy. Soc.,’ No. 146, p. 428.

But in the microscope it appears quite the ten thousandth of an inch, or nearly four times larger than it ought to be, if light had no undulatory waves. And this too, whilst using the most exquisite glasses obtainable. This tremendous fact shows how hopeless it is to expect brilliant disks to appear of the proper or natural size, if I may so speak, in the microscope.

In view of the extraordinary result of the measurement of solar spectra already alluded to, a very natural doubt will arise in the minds of those who have not had practice in this method of miniature, as to the correct effect of the glasses. Now the best process for solving the doubt is to watch the spider threads successively reduced from ten to fifty times. The operator will find it a slow process, as every possible adjustment of centricity and correction for aberration must be carefully attended to the whole time, as well as arranging the light. It cost me at first about six hours' work. But then the miniatures become so exquisitely smaller, the work in its very novelty becomes fascinating, and encourages one to persevere. The observer will have no chance of splendidly defining the millionth of an inch unless he is accustomed to high-power manipulation, and remembers that both upper and lower objectives must be both corrected by the screw collars for uncovered objects (dry or immersion), and change of distance of the focal images. Something too should be understood of the effect of change of "aperture" upon the appearance of a transparent cylinder of spider silk. It must be remembered that the aperture of the miniaturizing objective, as this is used in an inverted position, is greatly reduced as regards the incident pencils emanating from the spider lines.

A pencil of rays proceeding from the cross or intersection of the spider lines about six inches from the back glass, enters it at an aperture of a few degrees only, perhaps ten. Now if a cylinder of glass or spider gum be viewed with a low-aperture objective (say $1\frac{1}{2}$), it will present two black borders, and the breadth of these borders narrows as the aperture is increased, and *vice versâ*. Also when the spider thread is diminished more and more, these black borders appear almost to coalesce until only a black line appears. The middle bright part vanishes with attenuation.

Then it may be further urged that a very fine glass forms miniatures of an object, theoretically, by merely optically reversing the rays as perfectly, indeed more so, than in the enlarged image of the same object. If therefore we can see the minute spider line very perfectly magnified one thousand times, we can, *a fortiori*, see the miniature, which is only fifty times smaller, with great precision. So much for the objection against the accuracy of miniatures formed by an excellently adjusted objective.

But a crucial test is supplied by observing sets of cross wires separated a small space. Fortunately I had requested Mr. Browning

to put a double set of cross wires, and also a set of parallel wires, in the micrometer. The head of the instrument is divided into one hundred parts, and a half or quarter part is readily seen with the naked eye. I may here observe, when the wires are reduced thirty-eight times by the $\frac{1}{38}$ (as one division of the micrometer is the $\frac{1}{10000}$ of an inch of motion in the wires), a single division for the miniature then reckons $\frac{1}{38000}$ th. But I found a quarter of a division made a perceptible difference in the apparent thickness of two coincident webs; *whilst three whole divisions separated the webs* so completely, that a narrow strip of light could be discerned between them (not much room here for swelling or enlargement of the lines!).

I then changed the glasses, putting the best glass in the body, and the older one (both newly formulated) in the micrometer: the definition was not so good. It required $3\frac{1}{2}$ divisions to separate the same lines.

This dividing of close lines by means of a very finely constructed micrometer is quite satisfactory to my mind, and I should hope conclusive as a *crucial* test to others who may witness it that the lines are very truly portrayed.

The following little circumstance has an interest of its own. Having conveyed my instruments home from the London Museum, S.K., I found the webs entirely covered with London dust. Upon getting them, however, into rapid vibration, I succeeded in shaking off nearly the whole before measuring them. A few minute particles adhere here and there; and though these webs are diminished fifty times—i. e. to the 300,000th of an inch—these particles of dust are visible on the web in this state of reduction. This result is the most surprising of all.

It was found that under this reduction (fifty times) it required five divisions to separate the spider lines, or a movement of $\frac{5}{10000}$ of the micrometer, i. e.

$$\frac{5}{50 \times 10000} = \frac{5}{500000} = \frac{1}{100000}.$$

Each division represented here on the micrometer head

$$\frac{1}{500000} \text{ of an inch}$$

in the field of view of the Microscope.

It is interesting to inquire what effect separating the spider lines has upon the discriminating power of vision. The optical conditions of seeing a black line upon a white ground, and separating or clearly dividing between two close minute black lines, are totally different. The researches of Dr. Jurin, 150 years ago, and of Dr. Robinson, F.R.S., the astronomer, on the subject, are very interesting; but no observations have yet been made of the minute-

ness about to be related. The question arose, Is it possible to estimate a bright space between two spider lines when *total* separation is only the eight millionths of an inch, the lines themselves being the 8000th and the 7000th of an inch respectively, and reduced in the miniature thirty-eight times? Reducing the numbers to decimals, if S be the space reckoned between the centres of the spider lines, it is evident if t and t' be the spider lines in diameters, and x be the required interval (see Fig. 5),

$$x + \frac{1}{2}t + \frac{1}{2}t' = S;$$

$$\therefore x = S - \frac{1}{2}t - \frac{1}{2}t' = S - (\frac{1}{2}t + \frac{1}{2}t').$$

The value of S was found by carefully measuring the movement of the micrometer = $\frac{3}{100000}$, which just brought the bright separating interval into view. Therefore we have the required size of interval (considering it diminished thirty-eight times),

$$\begin{aligned} x &= \frac{3}{38 \times 10000} - \frac{1}{2} \cdot \frac{1}{38.8000} - \frac{1}{2} \cdot \frac{1}{38.7000} \\ &= 0.00000789 - 0.00000164 - 0.00000187 \\ &= \begin{array}{r} 0.00000789 \\ - 0.00000351 \\ \hline \end{array} \\ &= .00000438 \\ &= \frac{1}{230000} \text{ nearly,} \end{aligned}$$

or about half the interval between the centres of the wires.*

The astounding sight of wires or webs separated by an interval of light less than the two hundred thousandth of an inch can only be explained by the light being subdued. Indifferent glasses cause diffraction images, besides clouding over the view with residuary spherical aberration much more difficult of cure than the colour. Without this interval—I may say, this extraordinary interval—one might conclude the webs are in some mysterious manner enlarged in the miniature beyond the calculated value. And so they are in poor glasses; for the image appears blurred—swelled, as it were—or adumbrated. But now the lovely precision of definition witnessed in high-class glasses, not only of the webs, but of dust on them and specks on the lamp-glass, precludes any suspicion, in face of this interval, of the enlargement of the lines encroaching much upon its dimensions. Besides all this, as the webs pass and repass

* Putting the decimals into fractions,

$$S = \frac{1}{127000}; \quad \frac{1}{2}t = \frac{1}{610000}; \quad \frac{1}{2}t' = \frac{1}{532000}.$$

The above calculation, it must be remembered, refers to the effect of the micrometer screw diminished thirty-eight times by the Powell and Lealand $\frac{1}{2}$ best immersion.

each other, the smallest movement of the screw changes their apparent thickness before division or separation is seen.

The miniatures were measured as follows:—

At Distance, Inches.			Miniature reduced, Times.
$6\frac{1}{2}$	.. ..	Very old $\frac{1}{8}$ Powell and Lealand	49
$6\frac{1}{4}$	.. ..	1862 $\frac{1}{8}$ Powell and Lealand (immersion)	58
$6\frac{1}{4}$	.. ..	1875 $\frac{1}{8}$	55
7	.. ..	1878 $\frac{1}{10}$ R. and J. Beck "immersion"	140
7	.. ..	1878 $\frac{1}{20}$ Beck (dry)	118·6
$6\frac{1}{2}$	.. ..	1873 $\frac{1}{15}$ Gundlach (immersion)	91·3
$5\frac{1}{2}$	.. ..	1877 $\frac{1}{8}$ Zeiss (oil immersion)	49
$6\frac{1}{2}$	.. ..	1863 1-inch Powell and Lealand	6·07
$6\frac{1}{4}$	.. ..	1851 $\frac{1}{4}$ Andrew Ross	27·6
6	.. ..	1870 $\frac{1}{2}$ Wray	13·4
6	.. ..	1870 $\frac{1}{4}$	29·5

To accurately adjust the observing and miniaturizing objectives in the same optical axis is easily done with low powers. If both are equal in power, the test of the quality is very severe, as I have shown elsewhere.* With a then excellent Powell and Lealand $\frac{1}{8}$ made for me in 1862, and improved by them after its return to the makers, a fog is still seen when observed by their brilliant newly-formulated $\frac{1}{8}$ immersion. But still the spider lines are visible. It is not till objectives of equal and I may say of surpassing beauty of definition are opposed to one another above and below, nose to nose, that their exquisite powers of displaying fine black details are exhibited.

The Gundlach immersion is of very fine quality. On reference to the table, it diminished the spider lines 91·3 times when the distance between them and the miniature was $6\frac{1}{2}$ inches. This gave for the first and second lines ($\frac{1}{80000}$ and $\frac{1}{70000}$ th diameter respectively) miniature sizes of

1st web	$\frac{1}{730000}$ of an inch.
2nd web	$\frac{1}{640000}$ "

The sizes of the web No. 1 with the different objectives may thus be tabulated:—

Dist.	Inches focus.	$\frac{1}{4}$ Ross	$\frac{1}{8}$ Powell	$\frac{1}{8}$ Powell and Lealand	$\frac{1}{20}$ Beck
$6\frac{1}{2}$	1	1	1	1	1
	$\frac{1}{48000}$	$\frac{1}{220000}$	$\frac{1}{300000}$	$\frac{1}{460000}$	$\frac{1}{1120000}$

These were mostly at $6\frac{1}{2}$ or $6\frac{1}{4}$ inches. At a greater distance—10 inches—the diameters of the spider line of $\frac{1}{80000}$ with the two latter glasses would be,

$\frac{1}{8}$ Powell and Lealand	$\frac{1}{20}$ Beck
1	1
$\frac{1}{640000}$	$\frac{1}{1600000}$

* 'Phil. Transact.,' vol. ii., 1871.

These astonishing results, so contrary to what had been generally supposed, demand thorough investigation. And with a view to elucidate this unusually important subject, it will be interesting to inquire what is the visual angle of fine-line objects just visible by different observers.

	Diameter of Hair.	Distance visible.		Angle.
		feet.	seconds.	
Mr. Broun, F.R.S., 'Proc. Roy. Soc.' ..	·0026	36	1 $\frac{1}{2}$	
Mr. Slack, P.R.M.S.	·003	45 $\frac{1}{2}$	1	
With sun illumination and grey sky } background	·003	76	6-10ths	
Against white wall of house, sun still } shining	·003	113	4-10ths	
Lit up by sun glittering	·003	173*	..	

It is now requisite to determine what would be the visual angle of the spider line $\frac{1}{8000}$ of an inch miniaturized 140 times smaller with the Beck $\frac{1}{20}$, and then magnified up 1000 times by an eighth immersion with C eye-piece and about 10 inches of tube. Here

Visual diameter of web $\delta = \frac{1}{8000} \div 140 \times 1000$ at a distance of 10 inches.

Hence

$$\sin. \theta = \frac{\text{Perp.}}{\text{Radius}} = \frac{\delta}{10} = \frac{1000}{140 \times 8000 \times 10} = \frac{1}{11200} = 18 \text{ seconds nearly.}$$

The most ready way of getting the value of the fraction in seconds is by recollecting that $60'' = \frac{1}{34\frac{1}{38}}$ nearly.

Referring now to the former table, it will be found by simple arithmetic that since the Beck $\frac{1}{20}$ immersion shows theoretically a visual angle of 18 seconds, miniaturing 140 times, a glass reducing only fifty-eight times ought to show at an angle of $7\frac{1}{2}$ seconds at a power of 1000, and at a power of 500 at about 4 seconds. I see the line plainly, most charmingly defined with 500, and can even see them when miniaturized only thirty times. A good deal might be written on this extraordinary fact. As the aperture of the objectives is diminished the spider lines look blacker, and therefore *larger*. I reserve this question for future treatment.

In inferior glasses the spider lines are thickened, and, besides this, garnished with secondary lines, true diffraction lines, and this you may see. I first detailed the method of miniatures in the 'Philosophical Transactions' eight years ago; but I have had nearly twelve years' experience of this method, and I have several times recommended it to the microscopical world with great cor-

* The glittering line here would afford a broad spurious line greatly enlarged.

diality. It is superior to all others for detecting residuary errors, and when these are nearly compensated the miniatures of spider lines of any size are portrayed with enchanting precision.

To sum up:—The whole question of minute vision is the least visual angle first of naked vision, and secondly in instrumental vision.

It can hardly be expected that any Microscope, especially if connected with miniature apparatus, involving the total use of some twenty lenses arranged as nearly as possible with one continuous optical axis,—that any Microscope, I say, can ever equal the simplicity of human vision. But then, with the unassisted sight we can easily determine the limits of vision by receding from the object, and so making the visual angle smaller and smaller until the hair vanishes. This we may call the vanishing angle θ .

Now the art, if I may so speak, of making very minute objects visible, may be applied by my method to render them distinctly visible as they get smaller and smaller as miniatures, and at last reach the vanishing limit.

But to my eye, which is, I must confess, the worse for these experiments, lines can be formed under the Microscope which also by lowering the ocular power, or diminishing the miniature, resemble (I will not say absolutely identify themselves with) the vanishing phenomena of naked vision.

When I see spider lines sharply defined become beautifully less, and give one the same appearance as a hair upon a window-pane, vanishing as its visual angle reaches the limit, I am bound to believe, nay be assured, though against all modern belief and theory apparently, that I do see these exquisitely small lines just on the point of evanishment at a very small visual angle indeed. Anyone with ordinary sight can see a human hair on a window-pane against a moderately white sky at a distance of two feet and a quarter. This is an angle of 20 seconds.

At five feet it is	..	..	..	Nine seconds.
„ ten feet it is	..	..	..	Four and a half seconds.
„ twenty feet it is	..	..	..	Two and a quarter seconds.

Now, on comparison of the minute lines exhibited by me microscopically, the hair lines appear equally small in each mode, either by viewing them on a window-pane at a yard off, or in the microscope diminished fifty times, and then sufficiently enlarged. The irresistible conclusion from this comparison is that the eye can discover a minute hair line either on the window-pane or in the apparatus exhibited, at certainly a smaller angle than 20 seconds. In other words, the minute microscopic image appears as small as a hair several feet off, according to the acuteness of vision.

The highest experimental proof by comparison is thus strongly in favour of a line sharply and clearly defined, subtending an

angle of 20 seconds, and probably a good deal less, as 2 seconds is the visual limit that can be seen in the apparatus or by the eye alone.

Another very curious point is worth mentioning. Dr. Jurin 150 years ago stuck two pins on a window-pane, and found that when placed near each other he could not divide them except when the interval between them reached the wide visual angle of 30". But when only one pin was viewed, he could distinguish it at a visual angle of from 2 to 3 seconds!

This interesting fact explains what I have witnessed in separating the spider lines of the micrometer in these miniatures: the interval could only be seen when the lines were separated, centre to centre, three divisions (micrometer), each division representing $\frac{1}{400000}$ when a minuendo of *fifty times* was employed; yet one can see a most sensible thickening of the gossamers just beginning to separate by moving the micrometer half a division. From this, I presume, a similar phenomenon was produced, though very much less pronounced than Jurin's case. It is marvellous to me that a visible bright space between these lines can be seen at all when their centres are separated only three divisions, i. e. $\frac{3}{1000000}$ or $\frac{1}{300000}$ of an inch. Considering that there must be some residuary aberration, however small, and that the error of each set of glasses accumulates in the final image presented to the eye, it seems to me wonderful that, notwithstanding Jurin's fact, a division is visible between the gossamers at all with so light a movement as described.

In continuation of this subject, I propose to offer to the Society some researches on the effect of large and small apertures in object-glasses. I beg to commend this research to the earnest attention of the rising generation of microscopists. Unless I am very much mistaken, the idea propagated in reference to the limits of microscopic vision is totally erroneous; whilst for brilliant lines or minute disks of great brilliance, I have not the slightest hesitation in embracing the truths conveyed in the exquisite formula presented to the microscopical world by, I believe, independently, Professors Helmholtz and Abbe.

It is almost needless to remark that very firm supports and delicacy of the adjustments as regards spherical aberration and illumination are essential to the success of this refined kind of definition.

III.—On some Recent Forms of Camera Lucida.

By FRANK CRISP, LL.B., B.A., Sec. R.M.S., &c.

(Read 11th December, 1878.)

DURING the present year four or five forms of camera lucida have been brought forward, all claiming to be original, and to enable the observer to see more readily the image of the object and the point of the pencil at the same time, and I have thought it might be in some degree desirable to notice them—as a matter of history, at any rate.

(1) The first is that of Dr. Hofmann, the well-known optician, of Paris.

Fig. 1 shows the camera, properly so called, and Fig. 2 its transverse section.

The rays coming from the object, and passing through the lens C, meet the plate of silvered glass A, by which they are reflected to the transparent glass plate B, and thence to the eye through the

Fig. 3

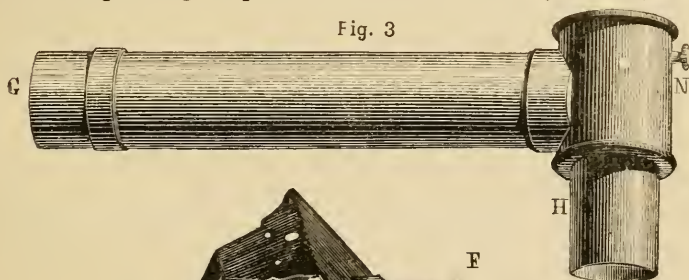


Fig. 4

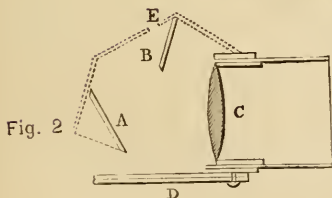
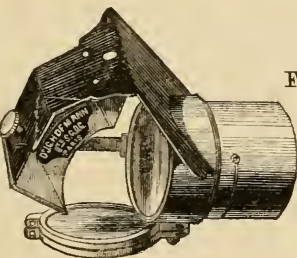


Fig. 5.

aperture at E. At D are two lenses of different foci, which can be interposed between the eye and the paper, as with the ordinary Wollaston form.

With a vertical Microscope the additional piece of apparatus

(Fig. 3), containing a reflector at N, is employed, the camera fitting over it at G, and the whole being inserted into the tube of the Microscope by the part H.

The instrument is thus suitable for powers up to 500; beyond this limit, however, it is desirable to substitute for the colourless glass plate B a tinted one.

The camera, to use Dr. Hofmann's expression, "suppresses all existing eye-pieces," but with objects requiring only small magnification to be within the field of the camera the arrangement is employed which is shown in Fig. 4. It consists of two plano-convex lenses of different foci, and slides into H.

The part No. 2 may be used alone, No. 3 being taken away. If the image of the object is still beyond the field of the instrument, the lens in No. 2 is unscrewed, and No. 3 replaced, which gives a second amplification; and with both lenses in their place a third is obtained.

Dr. Hofmann writes that this apparatus is the result of an expenditure of no little time and thought on his part, and that it has been very highly commended by leading men on the Continent.

(2) A second form also originates in France, and is the invention of M. Pellerin, who describes its principle in the '*Comptes Rendus*'* of the French Academy.

With the view, as he expresses it, of avoiding the weakening of one of the images through reflection by a transparent plate as in some forms, and the irksomeness of others which require that the object and the drawing should each be viewed with half the pupil, he suggests the following arrangement, which is an imitation of M. Cornu's polarizer, and gives two images of the same intensity and visible at the same time by the whole of the pupil.

A Wollaston camera lucida being made of glass having an index higher than the extraordinary index of spar, there are joined to the face which has an angle of 135° a plate of spar and a prism made of the same material as the camera, having its second face parallel to the face whence the rays emerge. Thus, at a suitable inclination, one-half the light coming from the object will be totally reflected as extraordinary rays, and a part of the light coming from the drawing will be transmitted as ordinary rays. The portions reflected and transmitted will be each one-half if there is no reflection of the ordinary rays, the condition for which is, that the glass of the two prisms and the cement which unites the pieces shall have the ordinary index, and in practice this can always be approximately attained.

For these assumed conditions, and the plate of spar being perpendicular to its axis, the following calculation is given of the field, which is then equal in all directions: in the interior of the glass

the extreme rays make an angle x the complement of the limiting angle,

$$\cos. x = \frac{n_e}{n_0}, \quad x = 26^\circ;$$

but that the faces of entrance and emergence may be cut perpendicularly to the mean direction of the rays, the angle of refraction of the extreme rays is $\frac{x}{2}$ and the angle of incidence y , so that

$$\begin{aligned} \sin. y &= n_0 \sin. \frac{x}{2}, \\ \sin. y &= \sqrt{\frac{n_0 (n_0 - n_e)}{2}}, \\ y &= 22^\circ. \end{aligned}$$

The field (maximum in these conditions) is 44° ; the instrument will take this in completely without rotation if the face attached to the spar is the third of the other, the aperture for the eye being near its edge. The angle adjacent to the spar is $90^\circ - 13^\circ = 77^\circ$.

To regulate the intensity of the two images, a polarizer may be interposed in the path of the most luminous rays, such an apparatus, for example, as M. Cornu's made of the materials above mentioned.

No drawing accompanies M. Pellerin's paper. He adds that a camera lucida of the same description may be made for vertical Microscopes by replacing the quadrangular prism by a parallelepiped with an angle of 77° .

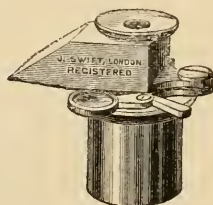
(3) The third arrangement is that of Mr. James Swift, shown in Fig. 5, and can be used at any inclination of the Microscope.

The principle of the instrument, as described by Mr. Swift, is that the image of the pencil and paper is received by a prism (enclosed in the box which projects on the left-hand side of the figure), by which it is reflected to a piece of neutral-tint glass placed at an angle of 45° over the centre of the upper lens of the eye-piece. The neutral-tint glass allows the image of the object in the Microscope to be distinctly seen, while that of the pencil and paper is at the same time visible on its first surface; no second image occurs by reflection from the back surface, owing to the tint of the glass.

A second disk of neutral-tint glass can be interposed when the light requires to be subdued to show the point of the pencil distinctly. It will be seen that in principle the instrument is an adaptation of Nachet's well-known form.

(4) The fourth form is that of Dr. Russell, which will be

FIG. 5.



exhibited by Dr. Millar this evening, and forms the subject of a separate paper.

(5) Although not a "form of camera lucida," yet it will not be out of place while dealing with this subject to call attention to a modification of a method of drawing objects under the Microscope originally described in 'Hardwicke's Science-Gossip' for 1867 (p. 236.) The method there suggested was to throw the image formed by the object-glass on to a sheet of paper fixed over a piece of common window-glass at one end of a "camera obscura," the Microscope being placed at the other end, and the eye-piece removed. Mr. H. E. Forrest, of Birmingham, now suggests that a rectangular prism should be placed over the eye-piece of a horizontal Microscope, thus throwing the image of the strongly illuminated object on to the paper on the table, the room being darkened. This method, while obviously requiring powerful illumination for high powers, is said to "enable even diatoms to be drawn with a $\frac{1}{6}$ objective."

I have purposely abstained from any criticism on the various methods above described, preferring to confine myself to a simple record of the fact of their invention.

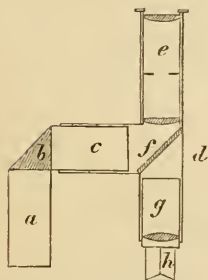
IV.—*Description of a New Form of Camera Lucida.*

By J. CUNNINGHAM RUSSELL, M.D., Lancaster.

(Read 11th December, 1878.)

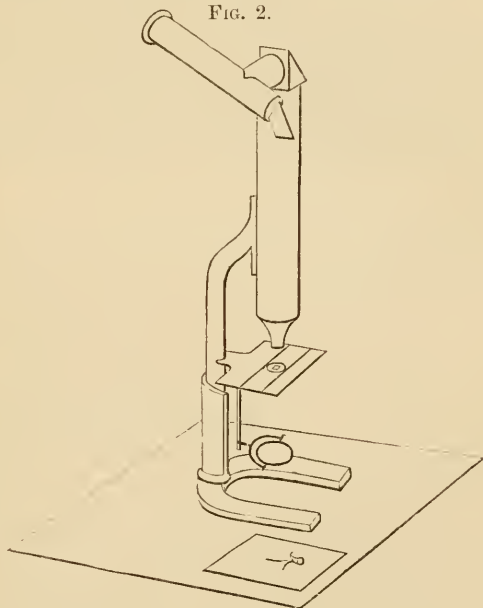
THE principle of this instrument is that, in place of the paper or its reflection being viewed by the eye directly as in the cameras hitherto constructed, there is formed, by means of a lens acting as the object-glass of a telescope, a real image of the paper at the same point as the image of the object formed by the microscopic objective, and these two images forming one combined image are viewed through the eye-glass of the Microscope. The advantages of this construction are that the images being as one it is impossible that the image of the object should shift even in the least degree upon that of the paper, and that the images being at exactly the same distance from the eye, they are both in focus at once, and there is no straining of the eye to accommodate it to both object and paper, as is apt to occur with other instruments. It also avoids the necessity of looking through a small aperture, the ordinary eye-

FIG. 1.



- a*, Tube fitting into the Microscope.
b, Rectangular reflecting prism.
c, Horizontal tubes.
d, Vertical tube (inclined when in use), containing
e, Eye-piece.
f, Plane reflector of tinted glass, and
g, Telescopic object-glass.
h, Erecting prism attached to the last.

FIG. 2.



piece being used; and it admits of a convenient inclination being given to the eye-piece while the body of the Microscope is upright.

The construction of this instrument is shown in the accompanying figures and is as follows:—A tube fits into the tube of

the Microscope: at the top of it there is a right-angled prism (in a box) which reflects the rays along a horizontal tube of convenient length; this is crossed at the end by a vertical tube, and at the intersection there is a piece of tinted glass which reflects the rays up the vertical tube. In the upper limb of the vertical tube is inserted the eye-piece, and in the lower limb the convex glass which acts as the telescopic object-glass, and the rays from which passing through the tinted glass form an image of the paper in the focus of the eye-piece. As this image is inverted, and it is necessary for easy drawing that it should be erect, an erecting prism is attached below the convex glass. In use the tube, which I have for simplicity called the vertical tube, is inclined, by a motion round the axis of the horizontal tube, to an angle of about 60° from the vertical, so that the lower face of the erecting prism becomes nearly horizontal, the paper is put on the table below it and focussed by sliding the object-glass in or out. The light on the object must of course be suitably modified so that the paper and pencil may be distinctly seen.

I do not put forward this model as the best possible form in which the principle may be applied; I have no doubt it is susceptible of many improvements, but the principle itself is, I believe, a sound one. It is equally applicable with the necessary modifications to drawing objects in the field of a telescope.

Lenses may be used to erect the image instead of a prism.

V.—*Immersion Illuminators.* By J. MAYALL, jun., F.R.M.S.

(Read 8th January, 1879.)

THE need of special apparatus for illuminating objects mounted in balsam, or other refractive medium, seems to have been clearly in Mr. Wenham's mind when he contributed his paper on "Illuminating Opaque Objects" to the 'Transactions' of the Society in 1856. The appliances then described were, a right-angled prism, a truncated hemispherical lens, used with his paraboloid, and the "paraboloid of solid glass with a flat top." These were, strictly speaking, *immersion illuminators*: the last is the original "immersion paraboloid." It was shown by diagrams that the illuminating rays were made to impinge on the upper internal surface of the cover-glass at an inclination beyond the "critical angle" (or flat-plate limit between glass and air), and reflected by *total reflexion* upon the object, which is then seen in a dark field.

The reflex illuminator designed by the same inventor, sixteen years later, was based on the same principle.

With these appliances, used according to the principle of construction, *dark-ground illumination* is produced with dry objectives, whether the illuminating rays are internally reflected from the cover-glass on to the balsamed object, or the object is capable of deflecting the *direct* rays from the illuminator so as to become self-luminous and visible by means of what may be termed *scattered* rays.

It has been generally held that, as stated by Mr. Charles Brooke, "the more minute structure of some objects is cognizable *only* by its influence on rays traversing the object at considerable obliquity." To this end many appliances have been designed to be used with dry objectives. In Amici's prism, Nachet's prism, the truncated paraboloids, right-angled prism, truncated hemispherical lens, Reade's dark-ground illumination, the "kettle-drum" diatom-prism, the reflex illuminator, and others too numerous to mention, we have either the use of an actual stop to block out portions of the rays, or the illuminator is placed in such a position as to provide light in particular directions. The main purpose in all is to utilize the more obliquely incident light to the exclusion of the central.

On the importance of regulating the obliquity of the illumination on the object in its relation to the apertures of dry objectives, I quote from Mr. Wenham's paper "On the Illumination of Objects . . .":—

"Practically it is found that there is a precise but different angle of illumination required for every aperture of the object-glass, in order to give the maximum of distinctness; or that will even at

* 'Quart. Journ.,' 1854, vol. ii. p. 152.

all develop the markings on difficult tests. For if we continue to increase the angle of the mirror [he refers to diagram] the object first acquires a pearly appearance, and is afterwards seen in a dark field known as 'Reade's back-ground [black-ground?] illumination' . . . but the markings have again become indistinct or disappear altogether, showing that it is needful to allow a small portion of the light from the source of illumination to pass into the object-glass, and through the object, that the striæ may either be rendered more visible by the rays that they intercept, or that the field shall be partly luminous."

Within the last few years the apertures of objectives have been so considerably extended by means of the immersion system, that, in order to utilize their fullest power, it has been found necessary to use an immersion system of illumination. By these means we obtain *direct* rays (i. e. rays other than those merely deflected by the object) from the illuminator at greater inclination than the critical angle, which certain of these immersions will transmit, producing a luminous field.

When the object is in balsam, and the base of the slide plane and in air, no rays can reach it from beneath at an obliquity greater than the limiting angle for balsam. In order that *direct* rays may *enter* the balsam beyond the inclination of 41° , we must have recourse to an immersion condenser, or something equivalent.

But it must not be supposed that the limiting angle at which rays could be admitted into balsam from beneath, through a flat plate of glass, imposes the same limit to the angle up to which an immersion objective could collect image-forming rays, supposing them to have got into the balsam,—which assumes that the image-rays above the object are limited by the angle of the *direct* illuminating rays from beneath. This erroneous view has had some currency, and may be thus stated:—*Because* the object in balsam cannot receive light from beneath beyond the limiting angle for balsam, unless we have an immersion system of illumination (supposing the base of the slide plane and in air), *therefore* there are no rays from the object beyond that limit to be transmitted by the immersion objective, however great its aperture; the question arising—"Where can such rays come from?"

It is evident that, independently of the angular direction of the illuminating rays, if there be an object in the field capable of *scattering* (and not merely intercepting) light, it is seen luminous by *scattered* rays. Regarded then as a *self-luminous* object, rays are nascent therefrom and scattered equally in all directions, and therefore at greater inclination than 41° . There is no theoretical difficulty in their reaching the second surface of the front lens of an immersion of suitable form, and in their being transmitted. They cannot, however, take part in the formation of the image by

a dry objective, because they are *internally* reflected by the cover-glass. These rays must be regarded as important for delicate markings, as evidenced by comparing the definition we obtain with the highest-angled immersions and dry objectives on a balsamed object with ordinary illumination,—that is to say, when the base of the slide is plane and in air.

The utilization of the whole of the very large cone of rays that might be condensed on the object by using an immersion illuminator having an aperture equal to that of the objective, in other words, the *direct* illumination of the whole aperture, is not the problem that has engaged the attention of those who have endeavoured to exhibit the fullest power of the apertures of immersions. It was long ago found that it is not so much mere *quantity* of light that is required on the object, as difference of illumination that can be rendered perceptible by the eye. The more difficult images are seen only as we utilize the extreme marginal aperture of the objective and the more oblique direction of the illuminating pencil. This can only be done practically by excluding all excess of central light. The objects on which the fullest power of the aperture is needed are generally so nearly of the same refractive index as the fluid in which they are immersed, that there is difficulty in making delicate differences of transparency perceptible. The immersion system of illumination becomes all-important to this end, as, by it, any required degree of intensity of light can be got upon the immersed object at the most favourable obliquity for the aperture of the objective.

It is found in practice that to obtain the fullest effect on the object, of the *extra-oblique* rays provided by immersion illumination, the objective must have an aperture capable of transmitting them, so that the field is luminous; they thus become a practical proof of the extent of the aperture. It follows also, as matter of observation, that up to the angle to which the objective refracts the *direct* rays from the illuminator to a luminous field, to that angle (or very nearly so) it refracts image-rays from the object; for we find that increasing the obliquity of the *direct* illuminating rays so as to approach to the dark-field produces, at the same time, distortion of the image,—showing that both systems of rays traverse the objective together.

The angle of the *direct* illuminating rays must not, however, be regarded as an essential condition of the *existence* of the aperture (as such). It proves the extent of the aperture of the objective by direct transmission; its effect in rendering visible minute structure is plainly matter of experience,—and experience shows that, so far as apertures have been carried, the gain has been in proportion to their capacity for *direct* transmission.

It will be understood that I refer only to objectives in which the corrections have been made to the fullest extent of the aperture; for it must be agreed that there is no such thing as *aperture*,

properly speaking, unless the image of a point be rendered as, approximately at least, a point.

Now, although, as I have shown above, Mr. Wenham understood the need of special means for illuminating obliquely objects in balsam, and the importance of the angle of illumination in relation to the aperture of the dry objective, I do not think he can be credited with having understood (much less foreseen) the important part the immersion illumination of balsamed objects would take in the development of the fullest power of immersion apertures. Indeed, as he has contended that the 82° limit of dry objectives obtains equally in immersions, he must be held to deny the existence of any aperture beyond 82° : consequently, the application of the immersion illuminators above mentioned, for *directly* utilizing any such aperture, must be regarded as a discovery quite apart from his original application of them for dark-ground illumination.

It appears to me that to Mr. Tolles is due the merit of first applying immersion illuminators to balsamed objects in connection with immersion objectives for the distinct purpose of utilizing by *direct* transmission the excess of "interior angle" beyond 82° . He was the first to produce objectives having interior angle considerably beyond 82° , and to demonstrate their advantages. With these objectives a luminous field was obtained when the whole of the illuminating rays that can enter into a dry objective were blocked out, and none but rays beyond this limit admitted: thus exhibiting at once a luminous field and a definition of immersed objects by means of the *extra* aperture that had not been seen before. He appears to have experimented chiefly with the semi-cylinder, because of the facility it offered for immediately obtaining a reading of the precise degree of inclination the illuminating rays made with the axis, so as to determine the actual limit of the apertures of the objectives he had devised; the display of difficult test-objects being merely incidental to his efforts to improve the instrument.

Dr. Woodward has given special prominence to the principle of the immersion illumination, in its immediate connection with the development of the power of aperture, by his "simple device," in which he originally provided means to exclude all rays of less inclination in glass than 45° from the axis, so that no objective having "interior angle" less than 90° would give a luminous field with it: it thus affords a proof of his position in the aperture question. Viewing it as an illuminator only, Dr. Woodward has simplified the mode of mounting the prism, and slightly varied the angle in a second prism: his last paper referred to these changes. I was also led to design a modification of this device, which is, briefly, to utilize the four exposed surfaces of the prism by cutting them at different angles so as to approximate nearly to the semi-aperture of the objectives likely to be used. This purpose is attained with a

success approaching perfection in Tolles's "traverse-lens," which I hope to place before you shortly with the inventor's notes.

Many experimental devices have been made for the same purpose. At the last meeting I exhibited another modification I had had made of Dr. Woodward's "simple device"; also a nearly hemispherical lens and a small semi-cylinder conveniently adapted for use on the sub-stage.

I mention Hyde's oblique illuminator for its novelty in combining a condenser with prism-illumination. It is a right-angled prism with a lens of short focus cemented on the long face, and will give a beam of condensed light up to a high degree of obliquity. Captain Tupman brought it from America four years ago. I am not aware whether the inventor designed this for the purpose of utilizing by *direct* transmission the *extra*-oblique rays that can be utilized only by immersions having "interior angle" beyond 82° , or he intended such rays to produce dark-ground illumination only. The plan is ingenious. I have, however, found by cementing a small lens on one of the exposed faces of Dr. Woodward's prism the same results are obtained more conveniently.

I refer also to a plan of illumination which Captain Tupman informs me is due to Mr. Tolles. It consists of placing a suitable prism in immersion-contact, on the surface of the balsamed slide, so that rays from a bull's-eye lens may pass directly to the internal surface of the base of the slide at an inclination beyond the critical angle, they are then *totally* reflected to the object. This requires some care in the manipulation.

Professor Abbe has adopted the use of a small lens* placed in immersion-contact with the base of the slide; which is a very simple and effective plan, and has been known for some years past. It is really so practical as almost to supersede the more elaborate contrivances for use beneath the stage.

Lastly, I refer to a reflecting immersion illuminator which I have suggested to Professor Abbe, and which he has undertaken to have made for me by Mr. Zeiss: this will be placed before you when completed.

Immersion illuminators are designed to secure a particular angular direction to the illuminating rays while actually in the body of the fluid in which the object is immersed, with a view to utilizing incident light of great obliquity; used in connection with the highest-angled immersion objectives, they have given fair grounds to expect that the future of the most difficult investigations in microscopy will be largely dependent on their successful application.

* At the Meeting in June I erroneously stated that Mr. Wenham had used a similar lens for the same purpose many years ago. He used the lens for reflex illumination from the cover-glass—not for *direct* illumination.

VI.—*Note on a Revolver Immersion Prism for Sub-stage Illumination.*

By JAMES EDMUNDS, M.D., M.R.C.P. Lond., F.R.M.S., &c.

(Read 8th January, 1879.)

THE value of a right-angled immersion prism as a sub-stage appliance for the illumination of objects under the Microscope was shown by Mr. Wenham in the year 1856, in a paper * published in the 'Transactions of the Royal Microscopical Society.' Mr. Wenham's paper is illustrated with a woodcut showing a right-angled prism attached to the under surface of a slide by means of oil of cloves, balsam, turpentine, or camphine; light concentrated by a bull's-eye being deflected upwards by means of an Amici prism. In the same paper Mr. Wenham also shows how, by means of a hemispherical lens, or "a small paraboloid of glass with a flat top" similarly attached to the under surface of the slide, other methods of immersion illumination may be made effective and, as he says, "show the Diatomaceæ with a degree of beauty and delicacy that he had never seen equalled."

The Tolles Microscopes have now for some years had fitted to their stages deep spherical and cylindrical lenses to be used for immersion illumination, and the splendid oil lenses now made by Zeiss are sent out accompanied by a small lens to be attached to the under surface of the slide with cedar oil, in order to supply light on the same principle. Colonel Woodward also has recently favoured this Society with two papers developing this most valuable method of illumination for high-angled lenses, and he has combined with the right-angled immersion prism two screens of thin metal perforated in line with the object, so that entering light may, when necessary, be demonstrably limited to parallel rays at a determinate angle.

The oil of cloves, used as an intermedium by Mr. Wenham, has been adopted by Colonel Woodward. Cedar oil, castor oil, or pure glycerine (Price's) also answer perfectly. As to the light, it will be found that a $1\frac{1}{2}$ -inch achromatic objective serves much better as a condenser than a bull's-eye, and that an image of the edge of a paraffin-lamp flame should be accurately condensed upon the object.

I now have the honour to submit a new combination prism, con-

* "On a Method of Illuminating Objects under the Highest Powers of the Microscope." By F. H. Wenham, Esq. Read March 25, 1856. 'Transactions of the Royal Microscopical Society,' vol. iv. pp. 55-60.

structed for me by Messrs. Powell and Lealand,* which will, I think, be found to render immersion illumination more manageable and more generally useful. I have termed it the revolver prism, because, by its means, unrefracted light at four grades of obliquity may be successively thrown into the object simply by rotating the prism and altering the inclination of the Microscope. This prism is of hard white crown glass, and six or seven eighths of an inch in diameter. Above, it has a circular plane surface, with a border curving downwards so as to afford hold for a setting which does not rise high enough to touch the slide. Below, it has four facets produced by grinding down a spherical surface into two right-angled prisms, whose lower edges are located at right angles to each other, and whose faces respectively make with the top surface angles of 30° and 60° , 41° and 49° . These four facets, taken consecutively, are normal to light entering at 30° , 41° , 60° and 49° of obliquity to the optic axis. The prism is sprung into the top of a vertical tube deeply slotted for the passage of light to the various facets, each slot being cut down to a line at which the side of the tube would be intersected by the plane of the facet on the opposite side. Below, the tube screws or slides into an adapter, or expands into a ring for the sub-stage. The top surface of the prism connects to the slide by means of a minim of cedar oil or Price's glycerine, and glare is prevented by the fact that superfluous light is reflected out through the slot behind. Each slot is figured with the obliquity of the light for which it is cut, and by a simple addition the entering light may be demonstrably limited to a particular angle, as with Dr. Woodward's perforated screens.

By means of this immersion prism the obliquity of the illumination may be so graduated as to shut out the light field and the ordinary negative image in so far as is necessary to obtain the diffraction image at its best point. With light at 60° from the optic axis the diffraction image is so far isolated that *Amphipleura pellucida* in balsam may be seen upon a dark background with the new oil lens. With light at 49° or 41° the field becomes lighted in proportion to the angular aperture of the objective, and the diatom is finely displayed, but with light at 30° the lines disappear.

Amphipleura pellucida in air, whether upon cover or slide, may also be shown by this prism. If the diatom be upon the slide, an intense black-ground illumination may be produced through the higher-angled facets, and the lines are shown as green and black bands, as they are by means of the immersion paraboloid.† If the diatom be upon the cover, the two lower-angled facets will show it,

* I exhibited this prism on June 5, 1878, at the soirée of the Metropolitan Branch of the British Medical Association.

† "On the Paraboloid Illuminator." Vide 'Monthly Microscopical Journal,' August, 1877, p. 81.

but for full illumination the facet at 30° is required. Light emerging from the slide at 30° is, of course, bent down so as to strike the under surface of the cover at about 49° , and in this light the dry diatom may be splendidly resolved. In balsam, light at about the same angle (49°) seems to resolve the diatom best. With *Amphipleura pellucida* the light should in all cases strike the diatom *end on*, or it will not be resolvable. The brilliancy of the field also must be kept in due subordination to the influence of the diffraction image, and as the following method of procedure makes this very difficult object quite easy, I may perhaps be permitted to describe it.

1. By means of a four-tenths objective, a diatom should be selected, centred, and turned so as to lie exactly north and south in the field.

2. If light at 49° is needed, the corresponding facet of the prism should be turned to the front. The Microscope tube should be inclined through the complementary angle (41°), so that the facet stands vertical.

3. The lamp flame—edge on—should be set on a level with the object, and at eight inches distance.

4. A $1\frac{1}{2}$ -inch achromatic objective should be arranged in line, so as to condense upon the object a fine image of the lamp flame. In order to show that the image of the flame is accurately focussed upon the object, a piece of wet tissue-paper may be laid upon the top of the slide, or the image of the flame upon the face of the observing lens may be viewed through a side facet.

Under these circumstances the lines will be perfectly resolved if the lens have an adequate angular aperture and be properly adjusted. The method is very simple, but for want of it I have seen an experienced manipulator spend hours in "fiddling about for the lines," and utterly exhaust his eyes without determining whether or not the optical capacity of the lens on trial was at fault. By the method I have described, this difficult object may be resolved as easily as a Podura scale. If, when the lines are properly resolved, the eye-piece be taken out, there will be seen, on looking down the tube, at the southern edge of the field, a small clear image of the flame, and at the northern edge—diametrically opposite—a soft, greenish-blue diffraction image. Sometimes also an outline of the diatom crossing the field from one image to the other may be discerned.

The particular angles given to the prism now before the Society, were selected in order to enable a single prism to command the whole range of oblique illumination, and to enable so difficult an object as *Amphipleura pellucida* to be at once resolved whether in balsam or in air, and whether upon the slide or upon the cover. Through these facets, light at somewhat different angles may be

passed without practical detriment, as only the edges of the beam would become chromatized, or other angles may be given to the revolver prism. If two such prisms were to accompany the Microscope, one might be cut at angles of 25° , 30° , 35° , and 40° , in order to light objects to be viewed under high-angled light in air on the cover, or under low-angled light if in balsam. The second prism might be cut at 40° , 45° , 50° , and 55° , in order to light objects to be viewed on the slide in air with black background, or under the highest working angular apertures if in balsam. Difficult objects, when set upon the slide in air for black-ground illumination, require the cover to be very close down upon them, or they will not be resolvable by high-angled lenses.

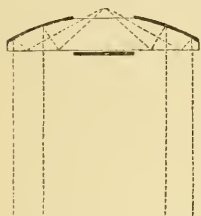
VII.—*A Catoptric Immersion Illuminator.*

By JOHN WARE STEPHENSON, F.R.A.S., Treas. R.M.S.

(Read 8th January, 1879.)

As the subject of Immersion Illuminators is now before the Society (and I am very glad it is so, for without their help the full resolving powers of the recent large-angled objectives cannot be utilized), it may not be out of place to lay before the Fellows a brief account of an immersion condenser of very simple construction which I devised in 1877.

The diagram shows the form and size of the instrument which I now use, although it is sufficiently obvious that other sizes, in the same ratios, may easily be made—in fact, I have such.



The apparatus is simply a plano-convex lens, worked on a 1-inch tool, and having a diameter of 1.2 inches, which is then “edged” down to 1 inch, as being more convenient in size, and as giving an aperture sufficient for our purpose.

The upper, or convex side, of the lens is cut down or flattened, so as to give a surface $\frac{1}{16}$ of an inch in diameter, with which the slide is to be connected, when in use, by a drop of oil or water.

It matters not which fluid is used as long as the objective has a numerical aperture not exceeding 1.33 (the index of water), and it is very improbable that this will ever be exceeded to any *great* extent, as 1.50 is the *ideal* maximum of even an oil immersion.

The upper curved surface of the lens is silvered, and beneath the lens, a flat silvered plate $\frac{1}{16}$ of an inch thick, and corresponding in size and position with the upper flattened surface, is balsamed.

It will be seen that the incident ray is normal to the under surface, impinges on the curved silvered surface, and is thus thrown back on the plane, or under surface of the lens, whence the more oblique rays, falling beyond the critical angle, are totally reflected, and converge to a focus, giving a numerical angle of $1.30 = 120^\circ$ in balsam.

The object of placing a silvered glass disk beneath the lens is twofold: in the first place, it reflects the less oblique rays which fall within the critical angle, and in the second it tends to diminish the spherical aberration which in this zone might otherwise be felt.

The stop is placed about $\frac{1}{8}$ of an inch, or less, below the condenser, and the opening used is of a lens-shaped form, as giving a broad beam without any appreciable spherical aberration in so narrow a zone of light.

It will be found that this instrument will work through any ordinary glass slip, gives a brilliant light, and, having no refracting surface, is necessarily achromatic, whilst the spherical aberration, as previously pointed out, is inconsiderable.

If used with a dry lens of the highest power on a balsam-mounted object, the light, unable to pass the upper surface of the covering glass, is thrown back on the object, giving opaque illumination ; on the other hand, with dry objects adhering to the slide, the well-known dark-ground illumination can be obtained with any objective I have yet seen.

VIII.—*The Thallus of the Diatomaceæ.*

By F. KITTON, Hon. F.R.M.S.

(Read 8th January, 1879.)

THE study of the living diatom has lately engaged the attention of many eminent foreign diatomists (M. P. Petit, Paris; M. J. Deby, Belgium; Count Castracane, M. Ardres, and others). The latest published observations are those of M. le Dr. Lanzi, of Rome, in his paper* on the “Thallus of the Diatomaceæ.” By thallus is to be understood the stipes, cushion, tube, frond, or mucous pellicle. The latter is the material by which the film of diatoms is attached to wet walls, buttresses of bridges, &c. He communicates some interesting facts connected with the reproduction of these remarkable organisms. “In a gathering of *Epithemia ventricosa* made in the Villa Pamphilia, in Rome, I observed that some portions of the pellicle were composed of a great quantity of round granular corpuscles of a greenish-yellow colour. Most of these corpuscles were, to all appearance, the same as those contained in the interior of the frustules of the *Epithemia*, and imbedded in a hyaline plasma. Such was the resemblance, that no one could doubt that the granular bodies in the plasmatic thallus and those in the frustules were alike.

“At another time I made a gathering in a fountain in the interior of the Forum of Trajan, of a *Cymbella* in a state of reproduction, and I was again able to see the round corpuscles. They were very small, and of the same colour as the endochrome. They were contained in the thallus, and resembled those in the frustules. I followed these germs through their phases of development; and by repeated observations I ascertained that, whilst increasing in breadth, they preserved their circular form; that afterwards they commenced to elongate, in order to acquire the lunate and naviculoid outline of the mature frustule.

“Of these growing forms, some remained attached to the thallus, and some became free. The number of these corpuscles was considerable; and one was easily convinced that they were the result of a new kind of generation. The disparity in size was so considerable, that it would have been absurd to suppose that they had been produced by fissiparity.

“I am able to report other similar facts observed in *Navicula ambigua*, *Nitzschia minutissima*, *Amphora ovalis*; but of these I shall say nothing, in order to avoid useless repetitions, and shall confine myself to describing *Gomphonema olivaceum* only, in which I have followed the series of transformations from the time the frustule containing the germs had changed into a sporangial cell,

* See ‘Annales de la Société Belge de Microscopie,’ vol. iv.

until the thallus became charged with germs and frustules in various stages of development. In this same thallus was also seen the gradual transformation of the corpuscles into rudimentary frustules, their growth, and lastly the development of the dichotomous peduncle. When this cycle was completed, the thallus contained three different forms—the sessile sphenelloid form, the pedunculate (either simple or dichotomous), and the perfect or free form. From the preceding, it appears that there arrives a time when the plasma contained in the siliceous cells acquire a considerable volume, owing to the rapid development manifested at the time of reproduction, and which cannot be contained within the walls of the frustule by reason of the want of elasticity produced by the deposition of silic. The frustules being unable to follow the growth of the plasma, the valves separate from the pressure; but previous to arriving at this condition, the protoplasm had commenced to undergo the changes necessary to the formation of the new cellules, and we are able to see an aggregation of hyaline masses destitute of an external membrane. These are the Moneres of Haeckel. Amongst them are some that remain for a long time as plastid gymnocytoes—that is to say, without an external membrane, as named by Haeckel—and form in this manner the amorphous or indefinite thallus (*mucus matriculis* of authors); whilst those that take the form of stipes, peduncles, cushions, or some definite form, appear to belong to the plastid lepycytoes, that is to say, invested with an extremely thin external membrane. This membrane, although scarcely visible with the Microscope, nevertheless limits the outline of the thallus. . . . I have determined to place the above-mentioned facts before diatomists, in order to call their attention to the study of the thallus of diatoms. The study of the function of the thallus in this large family seems to me to be full of interest.”

The presence of this “thallus” is by no means uncommon. I have detected it in many diatomaceous gatherings, particularly those from fresh water, but I never saw the corpuscles Dr. Lanzi mentions; they may not have been present, or, what is equally probable, I overlooked them. However, the discovery is of great interest; and I hope, with Dr. Lanzi, that other diatomists will turn their attention to the study of the living forms. The reproduction of the Diatomaceæ has not received that amount of attention the subject deserved. Their increase by self-division was the method first observed, more careful observations led to the detection of conjugation and production of sporangial frustules, or the formation of a sporangium by a single frustule; and we now find that another method has been observed, viz. that just described by Dr. Lanzi.

The author’s figure (1) represents a number of circular bodies immersed in the thallus of *E. ventricosa*, and also in the frustule;

(2) thallus of *Cocconema cistula*, representing the corpuscles in various stages of development. Unfortunately the amplification is not stated, a matter of some importance. It is also to be hoped that Dr. Lanzi will make some experiments to test the power possessed by them to resist desiccation without losing their vitality. In Herr Grunow's "New Diatoms from Honduras," 'M. M. J.,' vol. xviii. p. 184, Pl. 196, Fig. 4*b*, is described and figured a curious abnormality of *Cerataulus lævis*. Within the large frustule are two very small ones. Herr Grunow asks, "In what manner do these abnormal frustules multiply and reproduce a new series of normal forms? Certainly not by conjugation or self-division." Professor Cleve* figures a frustule of *Biddulphia aurita* with a small frustule within. In a note (p. 184), I suggested "that the endochrome, under certain conditions, might possess the power of producing (? by means of microspores) perfect frustules without conjugation." Dr. Lanzi's discovery confirms my supposition, and explains the formation of the small frustules within the large one.

* 'Bihang till Vet. Akad. Hand.,' band i. tab. iv. fig. 3*a b*.

NOTES AND MEMORANDA.

Researches on the Proboscis of Butterflies.—W. Breitenbach has undertaken a series of observations* on the hairs with which the proboscis of butterflies is covered, and on the relation of these to the curious “Cylindergebilde” or sheathed hairs by means of which many *Lepidoptera* are enabled to pierce the tissues of plants for the purpose of getting at the contained juices.

The ordinary typical hairs consist of a basal portion or cylinder composed of a dark chitinous material, and either partly imbedded in the substance of the proboscis or projecting freely from its surface, and of the hair proper, the proximal portion of which is imbedded in the cylinder, while the distal, usually by far the larger part, is free. In *Zygæna filipendule* the hairs on the greater part of the proboscis have the ordinary characters, but, near the free end of the organ, the edge of the cylinder is produced into four elevations, placed at equal distances from one another; the cylinder itself, moreover, is proportionally longer and the hair proper proportionally smaller than in the typical hair. In *Pieris* a similar structure obtains, but the cylinder is strengthened by longitudinal bands, one for each of the five points into which its edge is produced, and of a darker colour and firmer consistency than the rest of the cylinder. In *Epinephele Janira*, the size of the whole apparatus is greatly increased, the processes on the edge of the cylinder have become actual teeth, and the hair proper is so much reduced as to form a mere papilla just overtopping the circle of teeth. A structure is thus produced eminently fitted for piercing the tissues of plants. A further modification occurs in *Arge Galathea*, in which, besides the row of teeth round the edge of the cylinder, there are three other circlelets, encompassing, at equal intervals, its lateral surface: each of the four circlelets is six-toothed. In *Catocala hymenæa* the structure seems at first sight to be altogether different: the cylinder is provided with six vertical plates standing out from its lateral surface, and projecting over its edge in the form of sharp points: these plates may be considered as having been formed by the coalescence of superposed rows of teeth, such as exist in *Arge*.

From these observations it seems highly probable that the sheathed hairs have been developed from ordinary hairs by the gradual diminution of the hair proper, especially of its extra-cylindrical portion, and by the simultaneous increase in size and strength of the surrounding cylinder. The advantage accruing to the insect from the change is obvious; with a proboscis provided merely with ordinary hairs it would be able to take advantage only of free nectar, that is juice actually poured out by the secreting glands of the plant, whereas with the sheathed hairs it would be able to pierce the cell-walls and derive an additional quantity of nutriment by drawing upon the internal juices. This view is supported by the fact that *Lepidoptera* visit flowers which produce no free nectar.

* ‘Archiv f. Mik. Anat.,’ vol. xv. p. 8.

Contributions to our knowledge of the Protozoa.—Professor A. Schneider has a short but important paper (with a plate) on this subject, in the 'Zeitschrift f. wiss. Zool.,'* in which he describes his recent observations on *Actinosphaerium*, *Miliola*, *Trichosphaerium* (a new genus), and *Chlamydomonas*.

Actinosphaerium Eichornii.—Schneider's comparison of his own researches with those of Brandt, Greeff, and F. E. Schulze, lead him to think that this species really includes four distinct species, agreeing with one another in the vegetative condition, and differing only in the reproductive stage. The observations on which this opinion is based are shown in the following table compiled from Schneider's paper.

	<div><div>1. After the completion of the process of division, each of the two spheroids comes to lie in a special cyst, or rather in a special compartment of the common cyst: the spheroids do not subsequently unite, and their siliceous case is single (Schneider).</div><div>2. After division the two spheroids do not, or not always, lie in special cavities in the cyst: after the process of division the two spheroids unite again: their siliceous case is double (Greeff).</div></div>	Species A
I. In the process of division the nucleus divides repeatedly, and a number of the nuclei thus formed pass into each of the resulting spheroids.		
	<div><div>3. After division the spheroids conjugate (Brandt).</div><div>4. Conjugation of the spheroids does not take place (Schneider, F. E. Schulze).</div></div>	B
II. In the process of division the nucleus disappears, new nuclei afterwards appearing, one of which passes into each spheroid: the siliceous cases are thinner than in (I.).		
	<div><div>3. After division the spheroids conjugate (Brandt).</div><div>4. Conjugation of the spheroids does not take place (Schneider, F. E. Schulze).</div></div>	C
	<div><div>3. After division the spheroids conjugate (Brandt).</div><div>4. Conjugation of the spheroids does not take place (Schneider, F. E. Schulze).</div></div>	D

A further evidence of the distinctness of this form is afforded by the difference in their habits: of the two observed by Schneider, the species A, from the canal in the Berlin Zoological Gardens, fed chiefly on *Cyclops*, to which it clung by its pseudopodia, allowing itself to be carried about by its prey until the latter was killed: the species D, from ditches at Giessen, never devoured Cyclopidae, but fed chiefly on *Chlamydomonas*, and amongst higher animals confined itself to the smaller Rotatoria.

2. *Development of Miliola*.—In a species of this genus observed at Föhr, distinct nuclei were observed. Multiplication took place by the protoplasm being divided into nucleated masses, of which there were finally seen to be two kinds; small naked cells, probably representing spermatozoa, and large oval cells provided with a distinct membrane, and seeming to represent ova. No stage was found between these latter, and germ masses, consisting of a very distinct cell-wall enclosing contents half protoplasmic, half fat like. The fatty body disappeared, and the germ was converted into a young *Miliola*, with a single, globular, thin-walled chamber, provided with one large aperture and several small ones, through which pseudopodia were protruded: no nucleus was visible in this stage. The tubular portion of the shell was seen to begin as a hand-shaped process near the mouth. The young *Miliolae* continued to grow through the winter, and then the

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 446.

formation of germs began anew, but this time, apparently, asexually, as no sperm-cells were seen.

In a vessel of sea-water containing *Miliolæ* from Heligoland, were found small sandy accumulations, containing a transparent, hardish substance, devoid of silica, and enclosing about fifteen spaces containing capsules. The contents of these capsules were of four kinds, firstly, a great number of bright *Euglena*-like bodies, devoid of flagella, but exhibiting movements, probably spermatozoa; secondly, masses of protoplasm, probably ova; thirdly, undoubted young *Miliolæ*; and fourthly, some of the capsules were empty and probably represented empty sperm-capsules.

It will be seen at once that the evidence for the sexuality of *Miliola*, brought forward by Schneider, is by no means complete.

3. *Trichosphærium Sieboldii* (nov. gen. et sp.).—This species was discovered in water from Ostend, where it existed in such quantities as to form a white powder. Its shape is generally ovoidal, but undergoes considerable changes, so slowly, however, that the changes could not be followed by the eye. The surface is thickly covered with long bristle-like filaments (Borsten), which are unaffected by potash, but dissolve in dilute acetic or hydrochloric acid, without evolution of gas. When these bristles are dissolved, the animal is seen to be covered with a fine membrane produced into short cylindrical tubular processes, through each of which a delicate protoplasmic filament, slightly longer than the bristles, is protruded. *Trichosphærium* forms an intermediate genus between *Lieberkühnia* and the ordinary calcareous Foraminifera.

4. *Chlamydomonas*.—The author describes three species of this alga, *C. pulvisculus*, *C. tumida*, and *C. radiosa*, and also gives an account of the conjugation in the first-named species.

Cochineal for Staining.—Dr. Paul Mayer,* of the Zoological Station at Naples, when making experiments to find an alcoholic carmine solution with which to stain satisfactorily entire chitinous membrane, tried the tincture of cochineal, which not only answered the desired purpose, but showed itself suitable for general application wherever it is required to stain by an alcoholic method animal tissues preserved in alcohol, and to keep the preparations thus obtained in a resinous medium.

The pulverized cochineal is left for several days in contact with 70 per cent. alcohol, 8–10 c. cm. to a gramme, and the dark red liquid filtered. *The object to be stained must be free from acid*, and it is best to lay it for some time previously in fresh alcohol of 70 per cent. According to the intensity required and the nature of the object, the staining takes from a few minutes (infusoria, marine larvæ, &c.) to a few days (the higher crustacea, large annelida, young cephalopoda, organs of vertebrata, &c.).—The subsequent removal of the staining material which is not fixed in the tissue, is effected with 70 per cent. alcohol, and takes days in some cases; it can never, however, be continued too long, and should not be stopped until the alcohol takes no more up.

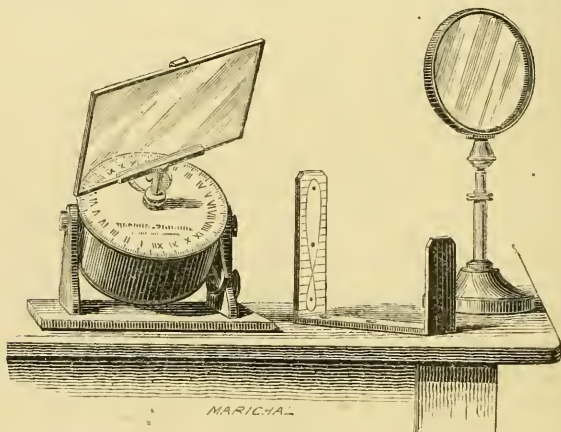
By this method, assuming that the object has been properly preserved, a very precise and nearly always intense nucleus stain is obtained,

* 'Zoologischer Anzeiger,' vol. i. p. 345.

and in by far the majority of cases this is not, as might be expected, coloured red, but hæmatoxylin. Dr. Mayer expects to be able to give the explanation hereafter of this strange phenomenon, which, however, is no detriment to the process. In consequence of the precision and tint of the stain, the preparations are for the most part not to be distinguished from those obtained with hæmatoxylin. The cochineal tincture also possesses, in common with the well-known alcoholic hæmatoxylin solution of Kleinenberg, the property of not altering the tissues; on the other hand, it compares favourably with it in the simplicity of its production and application, as also in the hold taken by the stain, which in this respect is equal to carmine. On the other hand, there is the defect that hitherto the attempt to stain large objects sufficiently deeply has not always succeeded; although the spinal marrow of the calf, in pieces one centimetre long and more, could be stained uniformly and deeply enough.

With a little care, permanent overstaining need not be feared, and can be removed by washing in acid alcohol (a drop of muriatic acid to about 10 c. cm. of 70 per cent. alcohol).

Prazmowski's Heliostat.—The woodcut represents this instrument, which, it is claimed, is much less complicated and cheaper than any existing form, and more easily regulated. The drum contains, as usual, the clock movement, and rotates a mirror upon its axis once in forty-eight hours. On the circumference of the drum is a dial with



the hours marked upon it, the spaces between each hour being divided into intervals of ten minutes. The drum rests upon supports, which allow it to be inclined in such a manner as to make the axis of the movement coincide with the direction of the earth's axis at the place where it is used.

This direction, which is given by the latitude of the place, need not necessarily be known to the operator, the adjustment of the instrument with respect to the latitude and the declination of the sun corresponding to the day of the year, being effected at once, and, so to speak, automatically. The apparatus is fixed after adjustment in

Fig. 1

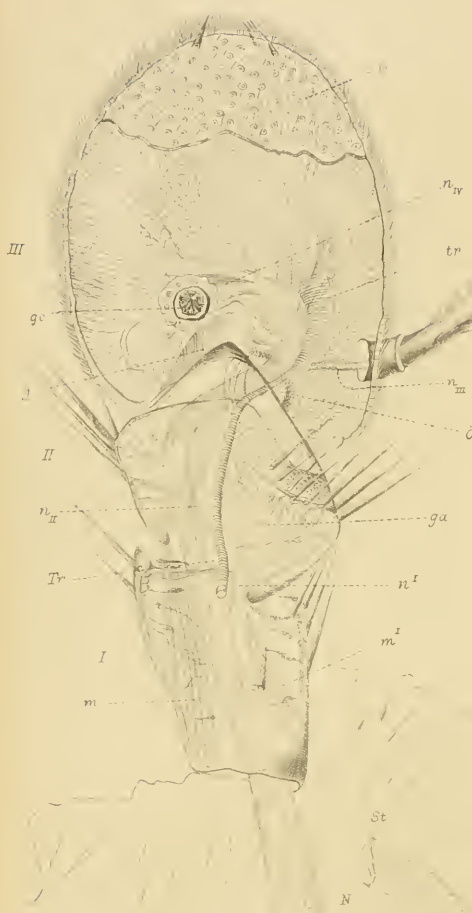


Fig. 1^a



Fig. 2



Fig. 1^b

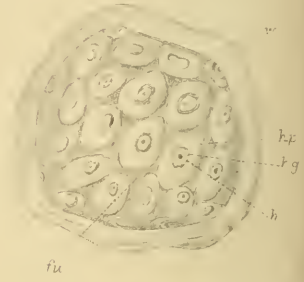
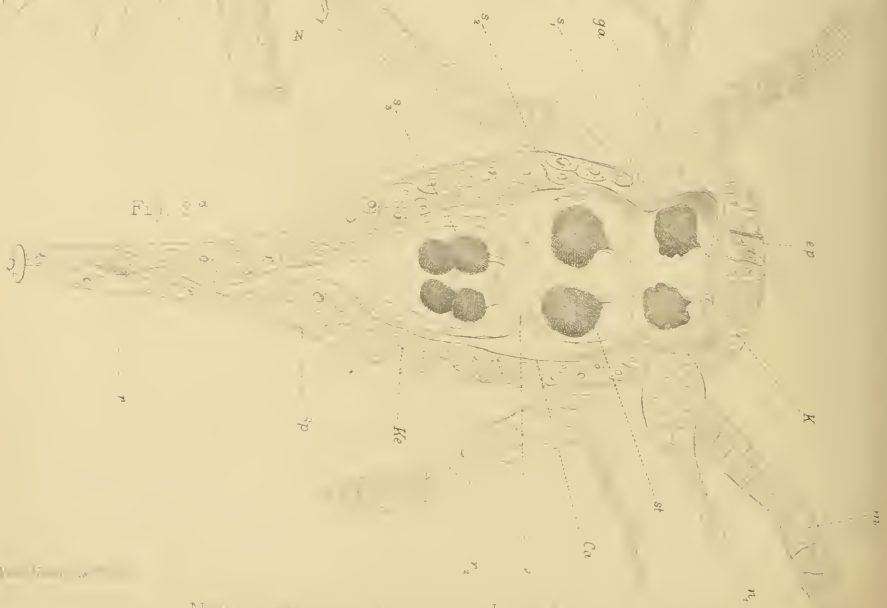


Fig. 2^a



the position which the latitude requires by a screw, which presses upon an arm marked with the degrees of latitude from 0° to 70° .

In order to adjust the instrument, it is placed on a perfectly horizontal surface; the mirror having been removed, a metallic rule (forming a diameter of the dial plate) is fixed, so as to slide easily on the axis of the movement, which traverses it like a spindle. This rule is terminated at its extremities by two perpendicular pieces, the shorter one being pierced with a small hole, the other marked with a division representing the equation of time and the declination of the sun for every ten days, connected by a continuous line. At the base of the shorter upright the rule has an aperture, through which can be seen the figures on the dial. To set the apparatus to the hour, the rule is turned round the axis like the hand of a watch until the exact hour and fraction of the hour at which the observation is made are seen in the aperture, and the division which represents it on the dial coincides with an index placed at the edge of the aperture.

For final adjustment it is only necessary to turn the instrument horizontally on the table, inclining it more or less on its support, until a ray of the sun, passing through the hole of the short upright, produces on the line of declinations placed on the opposite one, a small image of the sun which falls exactly on the point corresponding to the day of the year. This operation takes only a few moments, and is extremely easy.

This done, the instrument is adjusted; the screw on the circle of latitudes is tightened, the rule taken away, and the stem of the mirror is slid into the axis of the movement. The mirror can be turned independently, by which means the reflected ray may be directed to any azimuth. A fixed horizontal ray is thus obtained, which may be further reflected to another plane mirror, placed at some distance and movable on a pedestal, so that the ray may be directed wherever it is wanted.

When the exact time is not known, the instrument may still be adjusted in a way which is approximately correct, by adjusting it at about noon. It may also be adjusted first at about 9 A.M., and then about 3 P.M. Each time this is done a line is drawn on the table with a pencil, the foot of the instrument serving as a rule. These two lines form an angle which is bisected, and along the line which bisects it the foot of the instrument is placed. The latter is in this way adjusted for midday.

The clock movement has an anchor scapement, and could move a much larger mirror. A small dial placed on the drum and divided into sixty minutes, on which a minute-hand moves, allows the regularity of the motion to be verified. The dial of hours and the division for the days are enamelled, and consequently proof against weather. The whole apparatus is very portable.

New (Auditory) Sense-organs in Insects.—Professor Graber, of Czernowitz, announces* the important discovery of organs, probably of an auditory nature, which he has found, one in the antennæ of adult Diptera, the other in a larva of a species of the same order.

1. *Otocyst-like Organ in the Antennæ of Diptera* (Plate IV. Figs. 1, 1a, and 1b).—This was observed in *Syrphus balteatus*. The structure

* 'Archiv f. Mik. Anat.' vol. xvi. p. 36.

is best made out by treating the fresh antennæ with 1 per cent. osmic acid, transferring to absolute alcohol, clarifying with kreosote, and mounting in Canada balsam.

The supposed otocyst is a brown, thick-walled, chitinous sac, provided with hairs internally, having a diameter of 0.027 mm., and lying free in the cavity of the terminal leaf-like segment of the antennæ, towards the inner side of the joint between that segment and the preceding one. Under a high magnifying power the chitinous wall of the sac is seen to be covered with rounded or angular areas, the *hair-plates*, which are about 0.044 mm. in diameter, and in the centre of each of which is a depression, the *hair-pit*, giving attachment to one of the *auditory hairs*, which project in a radial direction towards the centre of the sac. These hairs are about two-thirds of the radius of the sac in length and 0.009 mm. in diameter at the base, where they are somewhat swollen. They contain a distinct lumen. Running through the wall of the capsule are fine pores corresponding to the hairs. The chitinous capsule is surrounded by a layer of columnar epithelial cells, each of which corresponds to one of the hair-plates, and the whole epithelial sac thus constituted is again surrounded by a delicate tunica propria.

The first and second segments of the antennæ bear only isolated, scattered, almost spiny hairs, but the terminal segment has a regular and dense covering of two kinds of appendages—true covering hairs formed by elevations of the cuticula, and articulated hairs agreeing generally with those of the other segments. The antennary nerve comes direct from the brain, and first branches when within the basal segment. A quantity of fine filaments are given off in the second segment, and go principally to the outer spiny hairs, swelling out at their roots into spindle-shaped ganglia. The other hairs of the first and second segments receive their nerves directly from the principal stem. Between the second and third segments the nerve makes an S-shaped bend, and, passing through the aperture in the joint-membrane, divides into filaments as in the second segment. A large branch is seen to pass direct to the capsule, but the connection of its fibres with the epithelial cells, although very probable, has not been made out.

An essentially similar structure is met with in the antennæ of *Sicus ferrugineus*, and in that of a species of *Helomyza*; in the latter case there is a dark-edged globular structure, which Graber considers to be the sac of the otolith, and suggests that the otolith itself, of which nothing was to be seen, was probably dissolved out by the kreosote.

Exact physiological observations are, of course, required, before the auditory nature of their structure can be considered as certain; but Graber mentions Paasch's observations that flies when startled by a sudden noise raise the third joint of the antennæ, as if "pricking up their ears."

It is also requisite to know something of the development of the organ, as to whether it is formed as an invagination of the integument, and also of its distribution in *Tracheata* generally. With regard to the latter point, Graber states that he has found it in many members of the sub-order *Brachycera*, but not in either of the families *Muscide* or *Tabanide*.

Professor Graber expresses his doubt as to the auditory nature of the structure discovered by Leydig in the halteres of certain Diptera, and also dissents from the views of the same authority as to the olfactory functions of the special rod-like appendages found by him on the antennæ of many Arthropods.

Plate IV. Fig. 1.—Right antenna of *Syrphus balteatus*, Deg. (in optical section). I., II., III., the three segments; *St*, Integument of epicranium; *N*, Antennary nerve; *n*ⁱ, *n*_{ii}, *n*_{iii} and *n*_{iv}, its first, second, third, and fourth branches; *m*, *m*ⁱ, Muscles of the basal segment; *Tr*, Trachea; *tr*, its vesicular dilatation in the terminal segment; *ga*, Ganglia at the base of the articulated hairs; *g*, Joint between the second and third segments; *Ö*, Opening in the same, through which the antennary nerve passes; *gc*, Auditory sac surrounded by its epithelium and *tunica propria*; *a*, Wall of the terminal segment, with the investing hairs and the roots of the articulated hairs. Amplification $\frac{180}{1}$ Zeiss Immers. L.

Fig. 1 *a*.—The otocyst (in optical section). *hh*, Auditory hairs; *hp*, Hair-plates; *hpo*, Pore-canals in the wall of the chitinous capsule corresponding to the auditory hairs; *Z*, Epithelial cells of the auditory sac; *tp*, Tunica propria. Amplification $\frac{1100}{1}$ Zeiss Immers. L.

Fig. 1 *b*.—The chitinous capsule of the otocyst (surface view). *w*, Wall; *hp*, Hair-plate; *h*, Root of the auditory hair; *hg*, Hair-pit; *fu*, Furrow between the hair-plates. Amplification $\frac{1100}{1}$ Zeiss Immers. L.

2. *New Organ in the Larva of a Fly* (Plate IV. Fig. 3).—In this case the main structure was made out by simply placing the transparent maggot under the compressorium. The organ in question is situated in the middle line of the dorsal side of the body, immediately posterior to the line of junction between the ninth and tenth segments. It is a pear-shaped sac, 0.3 mm. in length, with its narrow posterior end produced into a fine tube. It seems probable that tube and sac together are formed as an invagination of the external surface.

The sac and tube are made of a layer of epithelial cells, covered externally by a tunica propria, and lined within by a chitinous cuticle which bounds their lumen. Within the sac are contained four pairs of black opaque bodies of an irregularly rounded form, and suspended by hollow stalks. The first two pairs are of about equal size, being 0.03 mm. in diameter. The length of the stalk is 0.026 mm., and its breadth at the point 0.0018. The third and fourth pairs are smaller, and are only 0.02 mm. Probably the bodies themselves are also hollow, and have very thick, strongly chitinized walls, but their exact structure could not be made out, as they remained perfectly opaque even after treatment with potash. The most anterior pair of these bodies are attached, like berries, to the front wall of the sac; immediately behind them is a chitinous partition separating this anterior segment of the sac from the remainder. The second pair are not attached directly to this partition, but to the front wall of a special cellulose capsule (Binnensack), quite separate from the true

lining of the sac, closed anteriorly, but merely constricted behind. Similarly the third and fourth pairs of bodies, which are in close contact with one another, are connected to the front wall of another sac, the anterior closed end of which fits into the neck of the former, while its own neck extends nearly to the apex of the main sac. Probably these capsules are outpushings of the chitinous lining of the main sac.

It will be seen that there are thus formed three capsules, the actual lining of the sac and the two "Binnensäcke," which enclose one another like the coats of an onion, so that while the first pair of stalked bodies has only one layer of chitinæ outside it, the second pair has two, and the third and fourth pairs three.

The author, "proceeding by the process of elimination," points out that the organ must be either a gland or a sense-organ, and after going over the arguments for and against, comes to the conclusion that it cannot be a gland; and, further, that partly from its position and partly from its structure it cannot be intended for touch, smell, taste, or vision, and must therefore be a true auditory sac. The stalked bodies he considers to be otoliths, acting from their mode of attachment like the clapper of a bell.

Plate IV. Fig. 2.—The dipterous larva—natural size—showing the position (x) of the supposed auditory organ.

Fig. 2a.—The organ, isolated. K, Fundus of the sac; Sp, its apex; ep, Ke, its epithelium; Ca, Chitinous sac; s₁, s₂, s₃, its three internal capsules ("Binnensäcke"); e, constriction in the neck of the second of these; st, Stalked bodies; m, Muscles; n₁, n₂, First and second nerves; ga, Ganglionic swelling on the first of these; n, branch of the second; r, Tubular prolongation of the sac. Amplification $\frac{400}{1}$ Zeiss Immers. L.

At the end of his paper Graber gives the following useful diagram, showing in a tabular form the various forms of auditory organs occurring in the animal kingdom.

CHIEF FORMS OF AUDITORY ORGAN.

<i>Elementary Auditory Organ.</i> Isolated auditory cells and auditory hairs.		<i>Sac-like Auditory Organ,</i> or <i>Cystic Form.</i>	<i>Tympanic Form (with auditory rods).</i>	
Lower animals (?). Crustacea. Insects (?).			Orthoptera.	
Wall consisting of cells only. <i>Gymnotocysts.</i>			Wall with a chitinous cuticle. <i>Chitinotocysts.</i>	
With ciliated cells. <i>Ciliotocysts.</i>	Cells without cilia. <i>Non-ciliated gymnotocysts.</i>		With hairs. <i>Piliotocysts.</i>	Without hairs. <i>Apilose chitinotocysts.</i>
A- Mono- Poly- } lithophorous.	Poly-lithophorous, Ptychoptera. With rosette-like central organ.		A- Mono- Poly- } lithophorous.	With stalked otoliths (?).
Cœlenterata (?). Vermes. Mollusca. Vertebrata.	Larva of Corethra and Chironomus (?).		Crustacea. Insecta (antennary otocysts).	Fly larva.

The Fibrillæ of Filifera.—Oscar Schmidt has recently given an account* of the curious fibrillæ found among the ordinary horny fibres of the sponge *Filifera*. These bodies occur in the form of fine knobbed fibres, agreeing in chemical and microscopical character with the fibres of *Euspongia*, except for the fact that a cell-like body is regularly developed in the knob, when the latter separates from the softer axial portion of the fibrilla. Less frequently the formation and subsequent separation of one or two similar bodies occurs in the axial portion itself. Division of the fibrillæ also takes place.

Kölliker doubted whether the fibrillæ might not be parasites; but this conjecture is erroneous, as also is the former opinion of Oscar Schmidt himself, that they arise from the ordinary coarse fibres of the horny skeleton. The difficulties attending their isolation are so great, that the author has only recently succeeded in accomplishing it, thus making out for the first time their true form. He states that the perfect fibres are knobbed at both ends and resemble children's skipping-ropes. Their dimensions are subject to remarkable fluctuations, the long diameter of one and the same knob varying from 0.008 to 0.01 mm., and the length of a carefully isolated fibre from 1.4 to 1.6 mm.

The Ovule.—M. E. Warming, the Danish naturalist, has published in Danish the results of his investigations on the ovule. A translation in French appears in the 'Annales des Sciences Naturelles' (occupying more than 70 pp.), from which the following (being the author's "Conclusion") is extracted:—

I. Few organs have been the object of such varied interpretations as the ovule. Some (Schleiden, St. Hilaire, A. Braun, Strasburger, Wigand, Eichler, &c.) consider it as a bud, of which each integument is an independent leaf, or a disk (Schacht, Endlicher, Unger); the others as an organ of a foliar nature, in which the funicle alone (Rossman), or the funicle and the integuments, is an ovular leaflet or a lobe of a leaf. From this point opinions diverge. According to some, the nucleus is a part, a tooth of this leaf (Reissek); according to others, a new creation. In the latter case it is sometimes regarded as a bud (Caspary, Rossman), sometimes as a metablast, and latterly as the homologue of a sporangium (Brongniart, Cramer, Tieghem, Celakovsky). I agree with the latter opinion. There are also some observers who consider that the ovule may have a different significance in one plant and another, relying on its position either on the summit of the axis or on a leaf. I was formerly of the same opinion, but, thanks to the excellent reasoning of M. Celakovsky, I have recognized that the morphological significance of an organ does not depend absolutely on its position. Considering the perfect concordance in the structure of all the ovules of the Angiosperms, even those inserted on the most diverse organs, this opinion is inadmissible; and comparative study has done complete justice to it in negating the idea that the organ which is the sporangium in the Cryptogams, may become a bud in the Phanerogams.

It has been desired to invoke the law of shifting, according to

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. p. 661.

which the same physiological functions can be exercised by organs which are very different morphologically, and it has hence been concluded that that *must* be true for the ovule—though it may be possible, it does not necessarily follow that it is so. I pass by this illogical reasoning, therefore, until there has been discovered a well-established fact showing that the functions of the ovule are fulfilled by an organ which cannot be assimilated to a sporangium. A. Braun recognizes “that an organ analogous from a phylogenetic point of view to a sporangium developed on a leaf, and to the pollen sac of the staminal leaf, should be considered as an excrescence of the carpel;” but he adds that “in its ulterior development it may be elevated to the dignity of a vegetative point producing some leaves in the form of sheaths destined to protect the organ of reproduction which is formed on the vegetative summit itself.” In other words, that an organ of any morphological nature whatever may be transformed into another of superior dignity. These considerations are so wanting in foundation, they are so opposed to observed facts, that I can see nothing else on the part of the celebrated morphologist than an attempt to sustain, notwithstanding its contradictions, a favourite theory, but one nevertheless that cannot be supported.

II. I sum up briefly my results and my arguments, in comparing the different ovular theories.

The theory according to which the ovule is a bud has found support in the terminal position of a great many ovules, which makes them appear as the direct continuation of the axis. But M. Celakovsky has shown that the terminal position (or generally any position whatever of an organ) cannot demonstrate its morphological value, since there exist, for example, terminal leaves. He has proved that the part of the pistil which carries the ovule is everywhere of a foliar nature, even in the case of a central free placenta. In this he is of the same opinion as M. Van Tieghem, who has pursued an entirely different line. I agree in this opinion, and I have endeavoured to show that the history of development, in general very ineffective in similar questions, teaches us that the placenta or the terminal ovule in certain cases is a new creation on the summit of the axis. Amongst the Gymnosperms we find at first in the Cycadaceæ true carpellary leaves, and it has been established that the scales which bear the ovules in the Abietineæ are of a leafy nature, even when the scale cannot be interpreted as the fertile ventral part of the protecting scale, as I have mentioned hypothetically in my work on the Cycadaceæ. The concordances in the structure and anatomy enable us to admit that it is true also for the other Conifers (with non-terminal ovule). For the *Ginkgo* the ovular organ situated in the axil of the scales of the bud or of the leaves, must be considered as being composed of two leaves joined together, belonging to an axillary bud, like the needle of *Sciadopitys*. The two parts are even placed in the same manner, the physiologically lower face being turned towards the principal axis. Amongst the Cupressineæ and other Conifers with scales apparently simple, the union of two organs must be admitted, with MM. Van Tieghem and Strasburger. I admit that I am not able to apprehend in all its details the disposi-

tion of the ovule in *Taxus*, but I will willingly take it for a terminal leaflet with a monangian sorus equally terminal.

The carpels of the Angiosperms are distinguished from those of the Gymnosperms in that the former bear the ovules on the superior face, the others on the inferior when the ovules are not exactly marginal. The same observation applies to the stamens, those of the Conifers and the Cycadaceæ carry the pollen sacs on the inferior face, those of the Angiosperms on the superior face or at the side.

M. Celakovsky compares the stamen of the Angiosperms to the leaf of the *Ophioglossum*. Assuredly there is here a very ingenious comparison, but one which can only be placed in the category of bold and somewhat vague hypotheses founded on a too restricted number of observed facts.

The terminal position of the ovule does not prove that this organ is a bud; on the contrary, the placenta must be everywhere phyllomes.

The mode of development of the ovule, especially that of the Conifers, should tend according to some authors to its being considered a bud. It is impossible to have confidence in the history of development when the question is to determine the morphological nature of an organ. It everywhere requires a correction. M. Strasburger has allowed himself to be too much guided by preconceived ideas in the interpretation of the phenomena of development. Moreover, I have shown that the histogenesis of the ovule, as he has described it, is not correct, especially in relation to the development of the nucleus.

MM. Celakovsky and Cramer have shown that teratology cannot be invoked to prove that the ovule is a bud. The theory of Brongniart is much more admissible. In the first place, the carpels and the placentas are phyllomes; that being so, it is difficult to admit that the ovules are buds. It is true that buds may grow on a leaf, but to admit that the ovules are similar buds developed regularly on a carpellary leaf requires reasons of great weight. Moreover, the descending progression of the integuments is not in accord with this theory.

Secondly, the teratological cases show us everywhere the ovule (funicle and integuments) transformed into a lobe of a leaf on which the nucleus is a new creation, in the light of an outgrowth: this fact is confirmed by histogenesis. I may recall here that two nuclei have sometimes been observed on the same ovular leaflet, which does not agree with the theory of Braun, but very well with that of Brongniart.

Thirdly, the development of the nucleus is so like that of the pollen sac of the Angiosperms, that their homology cannot be doubted: further, the pollen sac itself is the homologue of the sporangium; therefore the nucleus must be compared to the macrosporangium. I do not know why it should be given the name of "sporocyst," which can scarcely be applied to any but the Marattiaceæ, for M. Strasburger has not yet demonstrated that the sporangia of the Equisetaceæ and the Lycopodiaceæ are sporocysts. This name could better be given to the pollen sacs of the Angiosperms.

The sporangia of the Cryptogams all grow on the leaves. The

comparison of the nucleus to the sporangium and to the pollen sac, confirms the results which we have obtained by the comparative study of the carpel.

The insertion of the nucleus on a leaf is proved for the Gymnosperms and a part of the Conifers; it may also be admitted in a general way for the other part of this family, but the details are still unknown.

The Gymnosperms, however, differ notably from the Angiosperms in several points, and constitute a separate branch which has not the same origin. The following are some of the differences which separate them: the forcing down of the female sporangium; the origin of the integument in two primordial points in a part of the genera; the development of the proembryo and the embryo; the disposition of the pollen sacs, and (in part) of the ovules on the staminal or carpellary leaf.

As the pollen sacs, wherever their position has been clearly recognized, are borne on the leaves; as all the facts, in the obscure cases, seem to indicate the same thing; as that is true for the ovule; as the sporangia of the Cryptogams, the common and primitive form of the phanerogamous reproductive organs, are equally developed on leaves, it must be admitted as a general rule that the reproductive organs of all the vascular plants are borne on the leaves, and that morphologically they are metablasts.

I shall be pleased if this memoir should contribute to the general acceptance ere long of the theory of Brongniart, the only true and admissible one—that I am now convinced of it is due in great part to the ingenious Slave botanist, Ladislao Celakovsky.*

Laboratory for Microscopic Work.—In the Zoological Laboratory at Newport, Rhode Island, U.S., recently established by Professor Alexander Agassiz, the tables for microscopic work are three-legged stands, of varying height, adapted to the different kinds of Microscopes in use. The whole of the northern side of the floor upon which the work-tables and microscope-stands are placed, is supported upon brick piers and arches independent of the main brick walls of the building, which form at the same time the basement of the building. The rest of the floor is supported entirely upon the outside walls and upon columns with stretchers extending under the crown of the arches reaching to the northern wall. This gives to the microscopic work the great advantage of complete isolation from all disturbance caused by walking over the floor. This will be duly appreciated by those who have worked in a building with a wooden floor, where every step caused a cessation of work and was sure to disturb any object just at the most interesting moment.†

A New Micrometer.—Spider-line micrometers, or micrometers of fine threads of platinum, are inconvenient from the thickness of the threads, from their expansion or contraction under thermic or hygrometric influences, from the difficulty of fixing them parallel to

* 'Ann. des Sc. Nat. (Bot.),' 6th series, vol. v. p. 250.

† 'Am. Jour. Sci. and Arts,' vol. xvi. p. 488.

each other at very small distances, or from their breaking so easily, and the difficulty of replacing them without the help of an expert.

In a micrometer devised by M. G. Govi,* the threads are replaced by the two edges of a slit made in a very thin layer of silver, gold, platinum, or other metal deposited on the surface of a glass slide which has its faces perfectly plane and parallel. Such metallic coatings may be obtained sufficiently opaque with a thickness of less than a hundred thousandth of a millimetre. The slit is made by a steel tracer so lightly as not to touch the glass. The breadth of the slit depends on the fineness of the tracer, its neatness not only on the shape of the tracer, but also on the thinness of the metallic layer. When broad slits are wanted it is best to remove the metal in parallel furrows rather than attempt to attain the same result by a larger tracer, which might produce slits with irregular edges. The metallic layer should be placed on the side whence the image comes, so that the rays which emanate from it, and the light which grazes the edges of the slit, may have to traverse the same thickness of glass and undergo the same modifications.

In consequence of the extreme thinness of the metal coating, the strongest eye-pieces give no sensible thickness to the edges of the slit. There is therefore nothing to fear from the effects of parallax even when the micrometer is applied to images placed in the extremities of the field.

There should always be a portion of the metallic coating removed normal to the slit, so as to allow the observer to see the images when they appear on the field of the Microscope, and when they pass off between the edges of the slit. It is a good plan to remove a little less than half the opaque coating, leaving intact the other half where the slit is. It is equally practicable to take off two equal bands of metal at the two extremities of the slit, and leave only the central zone in the field, which need not be very broad.

If a number of slits of different width be made on one plate, it is possible to avoid employing several micrometers.

The extreme tenuity of the metallic coating, its opacity, its rigidity, and the fact of its not altering under considerable thermometric and hygrometric variations; the possibility of making slits as narrow or wide as desired; the facility of substituting different slides in the same frame, are advantages in this micrometer which should, as it seems to me, induce observers to use it in place of the thread micrometer.

"Cell-Soul and Cellular Psychology."—Professor Haeckel has recently published his reply to the address on "The Liberty of Science in the Modern State," delivered at last year's meeting of the German Association, by Professor Virchow. He states that the views he expressed at Munich with regard to the soul of the cell, i.e. "that we must ascribe an independent soul-life to each organic cell," are but the natural consequence of Virchow's own teachings, viz. of the very fertile application which Virchow made of

* 'Comptes Rendus,' vol. lxxxvii. p. 557. The micrometer as described is intended more especially for meteorological observations.

the cell theory to pathology. He then proceeds to give the definition of the word "soul" according to both philosophical theories. First according to the monistic or realistic theory (i.e. that organisms have been *developed* naturally, in which case they must descend from the simplest and common ancestral forms), and then according to the dualistic or spiritualistic theory (i.e. that the different species of organisms have originated independently of one another, in which case they can only have been *created* in a supernatural way—by a miracle), he compares the simplicity of the former with the mystery and irrationality of the other, and shows the futility of Virchow's view that we cannot find psychic phenomena in the lower animals. "Volition and sensation, the most general and most indubitable qualities of all mental life, cannot be overlooked in the lower animals. Indeed, with most *Infusoria*, particularly with *Ciliata*, independent motion and conscious sensation (of pressure, heat, light, &c.) are so very evident, that one of their most patient observers, Ehrenberg, maintained up to his death that all *Infusoria* must have nerves and muscles, organs of sense and of mind (*Seelenorgane*), just like all higher animals.

Now it is known that the enormous progress which science has recently made in the natural history of these low organisms has reached its climax in the maxim that they are *unicellular* (a maxim which Siebold pronounced thirty years ago, but which has been proved with certainty only recently); therefore in the *Infusoria* a *single cell* performs all the different functions of life, including the mental functions, which in the *Hydræ* and *Spongiæ* are divided amongst the cells of the two germinal lobes, and in all higher animals amongst those of the various tissues, organs, and apparatus of a complicated organism. . . . By the same right by which we ascribe an independent 'soul' to these unicellular *Infusoria*, we must ascribe one to all other cells, because their most important active substance, the protoplasm, shows everywhere the same psychic properties of sensitiveness (sensation) and movability (volition). The difference in the higher organisms is only that there the numerous single cells give up their individual independence, and like good state-citizens, subordinate themselves to the 'state-soul' which represents the unity of will and sensation in the 'cell-association.' We must distinguish between the central soul of the total polycellular organism or the 'personal soul' and the separate elementary souls of the single cells, or 'cell-souls." This maxim is excellently illustrated by the interesting group of *Siphonophora*. There is no doubt that the whole *Siphonophora*-state has a very determined and uniform (*einheitlich*) will and sensation; yet each one of the single individuals which compose this state (or *Cormus*) has its separate personal will and sensation. Indeed, each one of these is originally a separate *Medusa*, and the 'individual' *Siphonophora*-state has resulted only by association and division of labour of this united society of *Medusæ*. Next to the unicellular *Infusoria* no phenomenon affords such ample and immediate proof for the truth of our cellular-psychology than the fact that the *human ovum*, like the ovum of all other animals, is a simple

and single cell. According to our monistic conception of the cell-soul, we must suppose that the fertilized ovum already possesses *virtually* those psychic properties which in the particular mixture of parental peculiarities (i. e. those of mother and father) characterize the individual soul of the new being. In the course of the development of the ovum the cell-soul of course develops itself simultaneously with its material substratum, and becomes apparent *actually* when the child is born. According to Virchow's dualistic conception of the 'Psyche,' we must suppose, on the contrary, that this immaterial being enters the soulless germ at some period of embryonal development (perhaps when the spinal tube separates from the germinal lobe?). Of course in this way the pure *miracle* is complete, and the natural and uninterrupted *continuity of development* is superfluous.*

Post-embryonic Formation of Appendages in Insects.—H. Dewitz was led by Darwin's remarks in the 'Origin of Species,' on the difficulty offered to the doctrine of natural selection by the neuters of insects living in communities, to make some researches on this subject, the results of which he sums up as follows:†—

The workers of ants possess very small wing-disks, situated precisely as in winged insects, and undergoing subsequent retrogressive metamorphosis. A figure is given, showing a rudiment of the posterior wing in an adult worker.

The thoracic appendages of ants first appear as a disk-shaped thickening of the hypodermis, which becomes separated into a central portion, the rudiment of the leg or wing, and a surrounding membrane; an aperture, opening outwards, being left in the latter. The membrane grows as a sack- or pocket-shaped invagination, into the interior of the body, and when metamorphosis takes place, the original aperture is enlarged to allow of the extrusion of the limb.

The young thoracic appendages of ants and bees secrete a chitinous cuticle during the larval condition. The difference between the limbs, formed during post-embryonic life, of *Holometabola* and of *Ametabola*, does not consist in the formation or non-formation of this cuticle, but in the fact that in *Holometabola* the newly formed appendages lie for the most part concealed in invaginations of the hypoderm, making their appearance first in the pupa stage, while in *Ametabola* they are visible from the first.

The formation of the wings of *Lepidoptera*, and, in the author's opinion, that of the appendages of all insects, takes place from the hypoderm, although probably their internal differentiation is always brought about by the penetration into them of nerves, tracheæ, &c.

The main difference between the females and workers of ants is not produced as in bees, by a different treatment of the eggs or larvæ on the part of the adult workers, but the future fate of the egg is settled while still in the body of the mother.

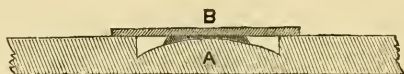
The Weber Slide.—The well-known live-box or animalcule cage serves the purpose of preserving and exhibiting living objects very

* 'Nature,' vol. xix. p. 113.

† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 78.

well, but it does not entirely prevent the evaporation of the liquid in which the objects are contained. The ordinary concave slide, though better than a plain slip of glass, does not fulfil all the requirements; and with such a slide it is difficult to keep the object in focus, except with very low powers.

To obviate these difficulties, Mr. Weber has reversed the form of the cell, and forms his slide as shown in the accompanying engraving, where A is the convex bottom of the cell, and B the thin glass



cover, a drop of water being held between them by capillary attraction. When the cover is cemented down by means of a little water-proof cement, the water cannot evaporate, and the whole arrangement forms an air-tight aquarium on a minute scale. The open space forms a chamber which retains a supply of air, and if the animal and vegetable life are properly balanced, life may exist in one of these slides for weeks.

In the woodcut, which shows the slide, the thickness of the slide, &c., is magnified about four times.*

The form of the crystalline Cones in the Arthropod Eye.—Oscar Schmidt contributes a paper on this subject to the 'Zeitschrift f. wiss. Zool.'† He commences by a short statement of the views of Exner and of Grenacher, the latest writers on the subject, and remarks that both they and all their predecessors consider each visual cone to be perpendicular to the corresponding corneal surface, so that only those rays of light which strike the cornea at right angles are of any avail in the formation of an image, being able to pass unbroken and unreflected to the apex of the cone.

The author then proceeds to describe the visual rods in the amphipodous genus *Phronima*. This animal possesses two pair of eyes: *lateral eyes* (Seiten-angen), situated in the usual position at the sides of the anterior part of the head, and in the same transverse section as the brain; and *frontal eyes* (Stirn-Scheitel-Augen), placed at the vertex of the head, very far posterior to the brain. Each eye is supplied with nerve-fibres from the optic ganglion, which fibres enter a mass of pigment of a brown or yellow colour visible with the naked eye, and become surrounded with a sheath closely adherent to the pigment. The pigmented body of the lateral eye is comparatively small, that of the frontal eye large and spindle-shaped; with it are connected, in each case, the proximal ends of the visual rods or crystalline cones, the distal ends of which abut against the external surface. In the lateral eye no two cones are found alike: those of the central portion of the organ approach most nearly to the conical form, and even they are not really conical, having an almost globular distal extremity or head, and a spindle-shaped swelling near the proximal end, where they become continuous with a nerve-fibre. In the frontal eye the visual rods are

* 'American Journal of Microscopy,' vol. iii. p. 253.

† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 1.

even less truly conical; each consists of a conical or rather globular head, a long central filamentous portion, and a proximal spindle-shaped portion. There is no cornea in either the lateral or the frontal eye, but the distal end of each cone comes into relation at the surface with a double cell, containing two (Semper's) nuclei. These double cells do not fit closely to one another, but leave triangular interspaces: the boundary wall between the two halves of which they are composed penetrates into a very evident cleft, marking the division of the cone into two longitudinal segments. Schmidt's observations give no support to Pagenstecher's view that this separation of the cone into two longitudinal moieties is an evidence of multiplication by division.

But perhaps the most important observation on these cones is that in hardly a single case is the axis of the visual rod at right angles to the external or corneal surface, so that Müller's theory of mosaic vision is here quite inapplicable, since there is neither the straightness of the refracting bodies, nor the contrivance for absorption of lateral rays required by that view of the action of the so-called compound eye. The author considers that the eyes of *Phronima* are mere makeshifts for image-forming organs, and that they serve only to distinguish different degrees of light and colour.

Observations on the visual rods of other Crustacea showed that in *Palaemon* many of the cones are straight, but that those at the periphery of the organ are oblique to the corneal facets, their proximal segments being strongly bent. In *Palinurus* this flexure sometimes amounts to 90°. In the lobster the rods are very irregular, hardly two being alike: their proximal segments show the greatest amount of variability as to size and degree of flexures, and have no resemblance at all to image-forming bodies.

The only insect examined by the author is *Dytiscus marginalis*; in it, as in the prawn, he finds that the rods towards the periphery of the eyes exhibit a marked flexure. The paper is accompanied by a plate.

Poison Glands of the Centipedes.—It has long been known that the Chilopod Myriapoda, commonly known as centipedes, which are carnivorous in their habits, kill their prey by a poison injected at the first bite of their formidable nippers. The seat of the glands secreting the poisonous fluid was, however, unknown, the organs formerly supposed to secrete the venom being found to pour their secretion into the cavity of the mouth and not into the nippers. Mr. McLeod, during a residence in Java, examined some of the large centipedes with which that island abounds, and especially *Scolopendra horrida*, and finding the glands which might easily be taken for poison glands had nothing to do with the nippers, which nevertheless always exhibited a very distinct orifice at the tip, he was led to search for the glands in the interior of those organs themselves.

The process he adopted is one that has of late given admirable results in the investigation of the anatomy of many animals; namely, the preparation of sections of them in various directions, after they had been immersed in melted paraffin, the subsequent hardening of which keeps all parts in their natural positions during the operation of cutting. By this means he detected the poison gland, which is

situated partly in the actual biting portion of the nipper and partly in the broad basal joint which supports the latter. The glandular apparatus consists of a chitinous duct leading to the orifice at the apex of the organ, and forming the axis of the gland. It is perforated in its course by a multitude of small apertures, each of which leads into a minute cylindrical tube, terminating in a long secreting cell, the whole mass of these cells being arranged in a radiating fashion around the duct. The entire organ is surrounded by a membrane, and has the general form of a four-sided prism. Notwithstanding its comparatively small size, Mr. McLeod has detected the same arrangement in *Lithobius forficatus*, the common European centipede.*

Microbia.—Under the title of “The Influence of M. Pasteur’s Discoveries on the Progress of Surgery,” M. Sédillot contributes a paper to the French Academy,† which he commences by pointing out that the microscopical organisms pervading the atmosphere (which Pasteur has shown are the cause of the fermentations attributed to the air, which is merely their vehicle), form a world by themselves, the history of which, as yet in its infancy, has already proved fertile in conjectures, and in results of the highest importance.

The names of these organisms are, however, very numerous :—Microzoaria, Microphyta, Aerobia, Anaerobia, Microgerms, Micrococci, Microzymes, Bacteria, Bacteridia, Vibrions, Microderms, Con-fervæ, Ferments, Monads, Animalcules, Corpuscles, Torulæ, *Penicillium*, *Aspergillus*, Infusoria, *Leptothrix*, *Leptotrichum*, Spores of *Achorion*, of *Fusus*, of *Oidium*, of thrush, Organisms of right and left tartaric acid, septic and septicemic Zymes, &c., terms which need to be defined and partly reformed. The word Microbia (from *mikros*, small, and *bios*, life) has the advantage of being shorter and of a more general signification, and of being approved by M. Littré, the most competent linguist in France ; and the author therefore proposes it for general acceptance, without, however, laying aside altogether those terms in use to designate varieties which have been more particularly examined. M. Pasteur also approves of the term.

The paper proceeds to discuss the changes in surgery which were brought about by the proof of the existence of Microbia, and “which threw a vivid light on the obscurity and false conceptions in which surgery had gone astray. From the highest antiquity medical science took notice of the preponderating influence of the air on health and disease ; but, in spite of the immense progress of science, time brought about no change in this point of view until the discoveries of M. Pasteur essentially modified the position of surgery and the treatment of wounds in particular. Surgeons were divided by different doctrines, reducible to a single one having for its basis ‘the dangers of contact with air.’ All were founded on observations which were exact and approached to truth, without, however, attaining it by reason of false interpretations and hasty generalizations. The discoveries of M. Pasteur at once reconciled the apparent contradictions, and explained the

* ‘Bull. Acad. Roy. de Belgique,’ vol. xlv. ‘Pop. Sc. Rev.’ N.S., vol. iii. p. 111.

† ‘Comptes Rendus,’ vol. lxxxvi. p. 634.

nse, in the treatment of wounds, of pulverulents, styptics, balms, ointments, caustics, camphor, iodine, alcohol, and a hundred other antiseptic substances which act as barriers to the contact of Microbia, or as agents of their destruction. Herein lies the principle of all preservative and curative treatment. Medicine and hygiene is applied to the destruction of the Microbia, external and internal, and to augment the vital resisting power of the patient.

The cultivation in fluids of Cohn, Raulin, and Pasteur has shown that certain species of Microbia (*Aspergillus niger* amongst others) have never been found amongst the preparations impregnated by the passage of a given quantity of air. Yet to procure this cryptogam it suffices to expose a slice of moist bread to the air, when they are soon seen to grow. This fact fully explains the variety of accidents to which wounds may be subject by reason of the numberless modifying circumstances which render them more or less amenable to the development and increase of different Microbia." It would be very desirable, he thinks, "to set up apparatus for analyzing the air in hospitals by which the degree of salubrity or infection would be daily determined."

Orchella as a Staining Material.—Dr. C. Wedl, of Vienna, describes the following process of staining animal tissues, in Virchow's 'Archiv für Pathologische Anatomie,' vol. lxxiv. p. 143. The so-called French Orchella-extract, from which the excess of ammonia has been extracted by gentle warming in a sand-bath, is poured into a mixture of 20 c. cm. absolute alcohol, 5 c. cm. concentrated acetic acid (of 1.070 spec. grav.), and 40 c. cm. distilled water, till a saturated dark-red stain is obtained, which must then be once or twice filtered. After the section has been hardened in Muller's fluid and spirits of wine or chromic acid, it is washed with distilled water. The latter is then got rid of by means of blotting-paper, and some drops of the staining fluid are applied to the section. The stain is taken up immediately by the protoplasm of the cells, whilst nuclei and nucleoli are not coloured. Horny or calcareous epithelial formations likewise take no stain. Connective-tissue cells are very deeply coloured, whilst the fibrillated intercellular substance of the connective tissue takes less of the stain. The basic substance of bones and that of the teeth take the stain, also the ganglion-cells with their prolongations. Fresh pathological formations also give sharp images when coloured with orchella. As medium the author used *levulose*.*

Construction of Eye-pieces.—In consequence of the discrepancies in published statements in regard to eye-pieces, Mr. W. H. Seaman, of Washington, has made a full series of measurements of the parts of eighteen eye-pieces by English and Continental makers. As the result of these measurements (which were laid before the Indianapolis Congress†), it was found that the common ratio between the focal lengths of eye-lens and field-lens was $\frac{1}{2}$, in one instance it was $\frac{1}{3}$, and

* 'Zeitschrift für Mikroskopie,' vol. i. p. 318.

† 'American Naturalist,' vol. xii. p. 838.

in one of older construction $\frac{7}{9}$. "The only general principle in regard to the interval separating the lenses is, that it shall be less than the solar focus of the field-lens; and when in the deeper eye-pieces and those which are orthoscopic it seems to exceed this limit, it must be remembered that in connection with the objective the eye-piece receives diverging rays, and for such its focus is beyond the solar focus. It may also be noticed that but a small part of the diameter of the eye-lens is actually used in the lower powers."

Malpighian Vessels of Insects.—Dr. E. Schindler has published an account, with three plates and a woodcut, of his extended researches on these structures.* This paper gives, first, an general account of the structure of the vessels in question, then an historical summary of the work of former observers, then a special account of the Malpighian vessels in the various groups of insects, and finally some concluding remarks, summarizing the results at which he has arrived. It is only possible here to give some account of the first and last of these sections.

The Malpighian vessels consist of at least three layers: externally a serous coat of nucleated connective tissue, then a delicate homogeneous tunica propria, and finally a single layer of glandular epithelial cells bounding the lumen of the tube. To these is sometimes added a perforated cuticular tunica intima. Elastic and muscular layers are but little developed, and the flow of the secretion, set free by the dehiscence of the gland-cells, is produced partly by its own gradual accumulation, partly by the movements of the other organs. The tubes may appear white, yellow, brown, green, or red, according to the colour and quantity of their contents. Their size and number vary greatly, their length being, as a rule, inversely proportional to their number.

The Malpighian vessels are exclusively excretory (renal) organs, and not, as has been supposed, biliary, or both biliary and renal. This is supported by their mode of development as outgrowths of the hind-gut by their early origin, and by the fact that they are functional before any bile is found and while the hind-gut is still a blind pouch, but chiefly by their close resemblance to the urinary tubules of higher animals, and by the nature of their contents. It is well made out that they contain specific urine-constituents, such as uric acid, acid sodic and ammonic urates, leucin, calcic oxalate, &c., and that no substance not already known in the urine of other animals occurs in them.

The chief facts tending to support the theory that these tubes are hepatic as well as renal, are the yellow and green colours often observed in them, and the polymorphism of their epithelial cells. With regard to the first of these points, Schindler states that the colour is dependent on a specific colouring matter in the blood plasma, that no bile pigments are present, and that the colour is very inconstant. The polymorphism of the cells was used as an argument for double function by Leydig, who supposed that certain cells had assigned to them a hepatic, others a renal function. But according

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. p. 587.

to Schindler there is no constancy in the occurrence of the different forms of cells, and moreover all of them contain the characteristic urinary concretions.

The urinary epithelium of insects contains none of the so-called *Dauer-zellen* or long-lived cells, but renewal of the cells takes place either by division, or (probably) by the nucleus of a cell which has undergone dehiscence, enlarging to form a new cell, its nucleolus becoming the nucleus of the latter.

Parasitic Crustacea.—M. Hesse gives the name of *Pachynesthus violaceus* and *Polyoon luteum* to two new parasitic crustaceans of microscopic dimensions (1–2 mm.), two females of which were discovered in the harbour at Brest, enclosed in the interior of a compound ascidian. The genera are new. M. Hesse remarks* in regard to their life-history:—

The completely stationary and so to speak secluded existence, to which these crustacea are condemned, does not require, as in the case of those which live in a free condition, perfect means of locomotion, for which they would have no use; those which they do possess are rather destined to serve for creeping than swimming.

Constantly shut up in an extremely limited enclosure formed of a more or less hard test of cellulose, they are obliged, in order to move in these narrow dwellings, to make themselves a passage by main force, and as Professor Giard has very well observed in his remarkable work on *Synascidia*, they are obliged to make galleries, by means of which they introduce themselves into the viscera; they penetrate into the ovaries, and produce such disorders as often cause the death of the whole colony, and might lead to the belief in the existence of a new species, although these modifications are only the result of the disturbances which they have produced in the individuals.

This work of burrowing, which I will compare to that of the mole cricket, results in the disappearance of the common cloacæ and their replacement by small openings very near together, the utility of which to these crustacea is easily conceived. Without these issues, in fact, the young embryos could not quit the enclosure nor disseminate themselves, and thus contribute to the dispersion of their species, and the males would be imprisoned and reduced to a state of captivity which is evidently contrary to the rôle which they have to fulfil, if I judge from crustacea closely allied to these, with which I am acquainted, and which are extremely agile and provided with all necessary means of swimming with facility.

Moreover, this liberty which the males enjoy easily explains their rarity, or rather the difficulty which there is in procuring them. They are rarely sedentary. It is of course on this account that they are more seldom met with than the females, which are condemned to live always in confinement. These latter are besides rather difficult to see, by reason of their extreme smallness; and if it were not for the eggs, which are generally of a very marked colour and which denote their presence, they would often not be seen.

The means of locomotion with which these crustacea are endowed

* 'Ann. des Sci. Nat. Zool.,' 6th ser., vol. vii. p. 7.

in order to surmount the obstacles which oppose their passage into the midst of the viscera of the Synascidians, consist of thoracic limbs, which are rather long and slender, and are terminated either by a single hooked claw, as in the *Polyoon*, or by several, as in the *Pachynesthus*. There may be further observed, in both, the cupulæ placed at the base of the legs from which they emerge, which, by their contractions and the ease with which they assume several shapes, can be applied like suckers to surfaces and be fixed there, or being lengthened into a point, they may serve as means of propulsion.

Finally, it is not uninteresting to observe the mode of termination of the abdominal extremity in these two crustacea.

In the one (*Pachynesthus*) it presents an appendage armed with two divergent points, in the form of a dovetail; underneath these are two other points directed perpendicularly, a combination which seems to me designed to draw up or drive away objects, as is done by the *boat-hook* employed by sailors for the same purpose.

Polyoon likewise has the extremity of the abdomen armed with two claws, which instead of being flat, are rounded, short, hooked, and terminated by a sharp point. They can also be raised, and then serve for propulsion, or be lowered, and on being drawn together, seize objects so as to draw them up and furnish a point of support for a retrograde movement.*

As to the alimentation of these animals, I am necessarily reduced to conjecture; but it does not seem to me possible that they should live otherwise than at the expense of their hosts, either on their material, their secretions, or their eggs.

The form of the mouth, which generally gives such valuable indications concerning its use, does not here lead to any definite conclusion, seeing that it can serve as well for suction as for mastication; we may therefore presume that it is employed for both purposes. It seems evident that it should be so, for without that the crustacea, who cannot seek their food outside, would infallibly perish if they did not find within their reach all that was necessary for them. (The species are figured.)

Improvements in Micro-photography.—Since the year 1844, when the first micro-photographic productions of Donné and Foucault appeared in the form of an atlas of microscopic anatomy, in which the plates were taken from daguerrotypes, histologists and microscopists have been unable to reconcile themselves to introducing photography generally as an integral part of microscopic research, in spite of the excellent publications of Gerlach and Benecke. Only in particular cases, when the inquirer was familiar with the application of photography to other purposes, has it been applied to produce pictorial representations of microscopic preparations. And yet the advantages which arise from such a method of delineating objects are beyond criticism and universally admitted.

The reason for this has been the complicated methods of preparing the sensitive plates. There was also required not only a micro-

* It is particularly remarkable that the greater number of parasitic crustacea which live in the interior of the ascidians, present similar dispositions.

photographic camera, which in one way or another had to be connected with the tube of the microscope, but also a small photographic atelier with a dark chamber. It required a certain time to learn how to prepare the plates, and many thought that they could only acquire skill in working from a course taken under a practical photographer.

The important advances in general photography have now been extended to the application of it to microscopical research, and endeavours have been made for some time to discover a process which will obviate the inconvenience of a photographic dark chamber and of having to prepare the plates each time, and which will allow of the sensitive plates being kept in stock, so that their complete sensitiveness is preserved for an indefinite time.

Of late years, the most various methods of preparing photographic dry plates have been proposed. The best, most tested, and surest process, however, is that of F. Wilde, of Görlitz, who has recently tested most carefully various approved forms of the dry process, and so improved it that anyone by keeping closely to the directions given with the plates, which can be obtained ready prepared, is in a position to produce excellent photographic pictures. A dozen prepared plates, each containing from 70 to 80 square centimetres of surface, cost *six* to seven shillings.

I* have occupied myself now for nearly twenty years in my leisure moments with the application of photography to subjects of natural history, either generally, or specially in microscopic work, and possess the requisite facility in all photographic manipulations. In spite of this, however, since I have become acquainted with Wilde's dry plates I have laid aside every other contrivance, and work only with that process. No method offers the same certainty, entails so little loss of time, and allows of such simple working, and I can therefore recommend it in the most pressing manner to my collaborators.

For the benefit of those who might wish to prepare the plates themselves, it may be stated that the sensitive covering consists of an emulsion of collodion, in which various salts of silver, chiefly bromide of silver, are suspended. Glass plates upon which a solution of 1 gramme of caoutchouc in 150 to 200 grammes of benzine has been poured, are covered with this emulsion, which, every time it is used, must be well shaken, and then allowed to rest again for some minutes. When the film has set a little the plates must be forthwith dried by the application of moderate heat, which may be done either in a small drying oven, or by moving them to and fro over a plate beneath which a spirit lamp is placed; after being dried, the plate is ready for use, either at once or at any subsequent time.

To use the plates all that is necessary is a conical tube for the end of the microscope, such as I have fully described in my work on 'Light as Employed in Scientific Research,' page 345, the wide end of which is placed uppermost. Connected with the tube is a cross piece on which the photographic cassette and the ground glass are placed. Such an apparatus, which can be got complete for about 20s., is quite sufficient to obtain the most beautiful micro-photographs

* Dr. S. Th. Stein, in 'Zeitschrift für Mikroskopie,' vol. i. p. 140.

by means of dry plates. If a considerable number of small cassettes are prepared, you can provide them with the dry plates in the evening, and the next day, as wanted, take micro-photographs. These, for which according to the intensity of the light one second up to several minutes are required, may be let stand till the evening if you are not in a position to darken your room, in order that you may at one and the same time develop and fix the pictures. The time required depends of course on the source of light. If direct sunlight is used with a low magnifying power, a perfect photograph may be produced in a fraction even of a second. With a magnifying power of 200 to 500 diameters, the time of exposure required with sunlight is from twenty-five seconds to half a minute, under some circumstances a whole minute. Bright daylight or sunlight reflected from a bright cloud requires even with low powers from a half to two and even three minutes. High powers cannot be used in diffused daylight. Magnesium light offers a good substitute, and by employing it with Wilde's dry plates superior "photograms" are obtained even with very high amplification. The time of exposure is in proportion to the intensity of the light. Magnesium light is about forty times weaker than sunlight, consequently the time of exposure required for a photograph with magnesium light is about forty times as long as with direct sunlight: for low powers therefore a period of about three-quarters of a minute, for high powers a period of from several minutes to a quarter of an hour. The latter period is requisite with the highest powers which as yet it has been possible to employ for photographic purposes.

The further development and fixing of the image is effected according to Wilde's directions in the following manner:—

First, over the plate which has received the impression there is poured, to develop it, a solution of

20 cubic centimetres alcohol,
5 " " distilled water,
10 drops of the solution B (below) of bromide of potash,

and it is left to the action of this mixture one to two minutes; then it is carefully rinsed with water till all greasy streaks have disappeared, and the water flows quite evenly over the plate.

In the development the following solutions are wanted:—

A. 5 grammes pyrogallie acid, 25 cubic centimetres alcohol, 25 cubic centimetres distilled water.

B. 5 grammes bromide of potash, 75 cub. centim. distilled water.

C. 3 grammes gelatine, 20 cub. centim. of acetic acid, 400 cub. centim. distilled water.

D. 25 grammes of carbonate of ammonia, 150 cub. centim. of distilled water.

Shortly before it is wanted for use a mixture is made of

40 drops of A.
20 " B.
10-15 " C.
15 cub. cm. D.

The latent image is washed over with this mixture and kept moist for several minutes by repeated washings.

After the image, complete in all its details, has by this means been developed, it is washed by pouring water over it, and fixed by dipping it in a solution of hyposulphite of soda (1 to 10). It is again washed, dried, and varnished.

The process of taking prints is conducted in the same way as in ordinary photography; a very practical and simple method is that by means of sulphate of iron. A durable prepared paper may be obtained from Marion and Gévy, of Paris, which gives excellent copies in blue colour, without any special skill being required.

Measure for Covering Glass.—For the exact measurement of the thickness of covering glass to hundredths of a millimetre two different mechanical appliances have hitherto been employed—the screw and the lever. The editor of the ‘*Zeitschrift für Mikroskopie*’* points out that the same object may be attained by a suitable adaptation of a movable wedge, the measuring wedge invented by P. Schönmann, which is distinguished by its great simplicity and solidity, and has recently been considerably improved.

The geometrical principle of the apparatus is as follows:—If a right-angled triangle abc (Fig. 1), whose hypotenuse $ac = 5$ cm.,

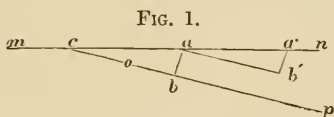


FIG. 1.

and its perpendicular $ab = 1$ cm., moves between the fixed lines mn and op in such a way that ac slides along mn ; then the line cb (1) always remains parallel to op , (2) the distance between the movable line cb and the fixed line op will always be one-fifth part of the distance which the point c , or any other point of the hypotenuse ac , has moved from its original position.

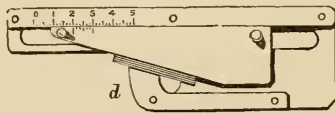
If, for instance, the triangle abc moves to $a'b'$, the point c will have moved over the distance $ac = 5$ cm., while the line cb will have moved to the distance $ab = 1$ cm. from the fixed line op .

It is on this principle that the construction of Schönmann's gauge is based, as shown in Figs. 2 and 3.

FIG. 2.



FIG. 3.



On one of the long sides of a brass base-plate a scale is fixed, the divisions on which are half a millimetre apart. On the other long side is a piece of brass bent inwards (d , Fig. 2). Between these a wedge, provided with a nonius, can be moved backwards and

* Vol. i. p. 283.

forwards by means of two buttons, and is prevented from falling out by proper guides in the slit of the base-plate.

When the long side of the wedge is contiguous to the edge of the beaked piece *d* (Fig. 2), the first line on the nonius coincides with the zero point of the scale.

To measure the thickness of a covering glass, the wedge is drawn back till the object to be measured can be placed on the edge of the piece *d* (Fig. 3). Then it is moved back again, pressing it slightly against the scale until a check is felt to the motion. The first line on the nonius will now no longer coincide with the zero point on the scale (Fig. 3). The number of divisions denoted by figures gives the whole millimetres, the number of smaller divisions the tenths of a millimetre, and the nonius the hundredths of a millimetre.

In using the instrument, care should be taken that it is free from dust, and that the motion of the wedge is easy.

By this instrument, when neatly and correctly made, the most exact measurements can be taken with a rapidity and ease that even a well-made screw micrometer will not admit of.

Origin of the Sexual Products in Hydroids.—J. Ciamician has made a series of careful observations * on the exact mode of origin of the ova and spermatozoa in two genera of *Hydroida*, and his results are altogether opposed to the theory of Van Beneden, according to which the ectoderm may be looked upon as the male, the endoderm as the female germ-lamella. In *Tubularia mesembryanthemum* the reproductive organs are sporosacs, and arise as bud-like processes composed of ectoderm and endoderm. The ectoderm at the distal end of this bud undergoes a process of invagination, and the bottom of the sac thus produced growing distalwards, forms from its endoderm the spadia of the sporosac, from its ectoderm the ova or sperm-mother-cells. The generative products of both sexes are therefore products of the ectoderm.

In *Eudendrium ramosum* the ectoderm on one side of the female generative bud undergoes proliferation, and pushes the endoderm towards the opposite wall: one of the ectodermal cells thus pushed in, enlarges greatly and produces an ovum, which is finally enclosed, by the completion of the process of virtual invagination, by a double layer of endoderm and a single one of ectoderm. So that in this case also, the ova are ectodermal products.

In the male gonophore of the same species, the case is quite different. Certain of the cells of the endoderm—the sperm-mother-cells—enlarge greatly, and their nuclei undergo extensive multiplication: as growth proceeds they become completely overarched by the neighbouring endoderm cells, and finally come to lie between the two layers, often having the appearance of belonging rather to ectoderm than to endoderm. Their contents become converted into spermatozoa, which are thus endodermal products.

There is, therefore, almost every possible variation in the origin of the generative products among the Hydrozoa; in *Tubularia* (Ciamician) and in *Hydra* (Kleinenberg), both male and female

* 'Zeitsch. f. wiss. Zool.,' vol. xxx, p. 501.

elements are ectodermal; in *Hydractinia* (Van Beneden) the ova are endodermal and the spermatozoa ectodermal; lastly, in *Eudendrium* (Ciamician) the ova are ectodermal and the spermatozoa endodermal.

Ciamician supposes that the generative products arose in the first instance indifferently from either layer, and that by further development they left their original position and came to lie between the two lamellæ.

Sir Joseph Hooker on the Modern Development of Microbotany.—Sir Joseph Hooker devoted part of his address as President at the last anniversary meeting of the Royal Society to the modern development of botanical science, there being, as he pointed out, perhaps no branch of research with the early progress of which the Society was more intimately connected.

“One of our earliest secretaries, Robert Hooke, two centuries ago, laboured long and successfully in the improvement of the microscope as an implement of investigation. He was one of the first to reap the harvest of discovery in the new fields of knowledge to which it was the key, and if the results which he attained have rather the aimless air of spoils gathered hither and thither in a treasury, the very fulness of which was embarrassing, we must remember that we date the starting-point of modern histology from the account given by Hooke in his ‘Micrographia’ (1667) of the structure of cork, which had attracted his interest from the singularity of its physical properties. Hooke demonstrated its *cellular structure*, and by an interesting coincidence he was one of the first to investigate, at the request, indeed, of the founder of the Society, Charles II., the movement of the sensitive plant *Mimosa pudica*, one of a class of phenomena which is still occupying the attention of more than one of our Fellows. In attributing the loss of turgescence, which is the cause of the collapse of the petiole and subordinate portions of the compound leaf which it supports, to the escape of a subtle humour, he to some extent foreshadowed the modern view which attributes the collapse of the cells to the escape of water by some mechanism far from clearly understood—whether from the cell-cavities or from the cell-walls into the intercellular spaces.

Hooke having shown the way, Nehemiah Grew, who was also secretary of the Royal Society, and Marcello Malpighi, Professor of Medicine in the University of Bologna, were not slow to follow it. Almost simultaneously (1671–3) the researches of these two indefatigable students were presented to the Royal Society, and the publication of two editions of Malpighi’s works in London prove how entirely this country was at that time regarded as the head-quarters of this branch of scientific inquiry. We owe to them the generalization of the cellular structure, which Hooke had ascertained in cork, for all other vegetable tissues. They described also accurately a host of microscopic structures then made known for the first time. Thus, to give one example, Grew figured and described in several different plants the stomata of the epidermis:—‘Passports either for the better avolation of superfluous sap, or the admission of air.’

With the exception of Leeuwenhoek, no observer attempted to

make any substantial addition to the labours of Grew and Malpighi for more than a century and a half, and however remarkable is the impulse which he gave to morphological studies, the views of Caspar Wolff in the middle of the eighteenth century (1759), in regarding cells as the result of the action of an organizing power upon a matrix, and not as themselves influencing organization, were adverse to the progress of histology. It is from Schleiden (1838), who described the cell as the true unit of vegetable structure, and Schwann, who extended this view to all organisms whether plants or animals, and gave its modern basis to biology by reasserting the unity of organization throughout animated nature, that we must date the modern achievements of histological science. Seldom, perhaps, in the history of science has any one man been allowed to see so magnificent a development of his ideas in the space of his own lifetime as has slowly grown up before the eyes of the venerable Schwann, and it was therefore with peculiar pleasure that a letter of congratulation was entrusted by the officers to one of the Fellows of this Society on its behalf on the recent occasion of the celebration of the fortieth anniversary of Schwann's entry into the professoriate.

If we can call up in our mind's eye some vegetable organism and briefly reflect on its construction, we see that we may fix on three great steps in the analysis of its structure, the organic, the microscopic, and the molecular, and, although not in the same order, each of the three last centuries is identified with one of these. In the seventeenth century Grew achieved the microscopic analysis of plant tissues into their constituent cells; in the eighteenth, Caspar Wolff effected the organic analysis (independently but long subsequently expounded by the poet Goethe) of plant structures into stem and leaf. It remained for Nägeli in the present century to first lift the veil from the mysterious processes of plant growth, and by his memorable theory of the molecular constitution of the starch-grain and cell-wall, and their growth by intus-susception (1858), to bring a large class of vital phenomena within the limits of physical interpretation. Strasburger has lately (1876) followed Sachs in extending Nägeli's views to the constitution of protoplasm itself, and there is now reason to believe that the ultimate structure of plants consists universally of solid molecules (not however, identical with chemical molecules) surrounded with areas of water which may be extended or diminished. While the molecules of all the inert parts of plants (starch-grains, cell-wall, &c.) are on optical grounds believed to have a definite crystalline character, no such conclusion can be arrived at with respect to the molecules of protoplasm. In these molecules the characteristic properties of the protoplasm reside, and are more marked in the aggregate mass in proportion to its denseness, and this is due to the close approximation of the molecules and the tenuity of their watery envelopes. The more voluminous the envelopes, the more the properties of protoplasm merge in those of all other fluids.

It is, however, to the study of the nuclei of cells that attention has been recently paid with the most interesting results. These well-known structures, first observed by Ferdinand Bauer at the

beginning of the century (1802), were only accurately described, thirty years later, by Robert Brown (1833). Up to the present time their function has been extremely obscure. The beautiful investigations of Strasburger (1875) have led him to the conclusion that the nucleus is the seat of a central force which has a kind of polarizing influence upon the protoplasm molecules, causing them to arrange themselves in lines radiating outwards. Cell-division he regards as primarily caused by the nucleus becoming bipolar, and the so-called caryolitic figures first described by Auerbach exhibit the same arrangement of the protoplasm molecules in connecting curves as in the case of iron-filings about the two poles of a bar-magnet. The two new centres mutually retire, and each influencing its own tract of protoplasm, the cell-division is thereby ultimately effected. This is but a brief account of processes which are greatly complicated in actual detail, and of which it must be remarked that, while the interest and beauty of the researches are beyond question, caution must be exercised in receiving the mechanical speculations by which Strasburger attempts to explain them. He has himself shown that cell-division presents the same phenomena in the animal kingdom, a result which has been confirmed by numerous observers, amongst whom I may content myself with mentioning one of our own number, Mr. F. Balfour. Strasburger further points out that this affords an argument for the community of descent in animal and vegetable cells; he regards free cell-division as derivable from ordinary cell-division by the suppression of certain stages."

The address then deals with the discoveries made during the last five years in physiological botany, more particularly by Mr. Darwin and Dr. Burdon Sanderson.

Lichens, Bacteria, Bacillus Organisms, and the Lowest Forms of Life.—Referring to these subjects, Sir Joseph Hooker said, "In morphological botany attention has been especially directed of late to the complete life-history of the lower order of cryptogams, since this is seen to be more and more an indispensable preliminary to any attempt at their correct classification.

The remarkable theory of Schwendener, now ten years old, astonished botanists by boldly sweeping away the claims to autonomous recognition of a whole group of highly characteristic organisms—the lichens—and by affirming that these consist of ascomycetal fungi united in a commensal existence with algæ. The controversial literature and renewed investigations which this theory has given rise to is now very considerable. But the advocates of the Schwendenerian view have gradually won their ground, and the success which has attended the experiments of Stahl in taking up the challenge of Schwendener's opponents, and manufacturing such lichens as *Endocarpon* and *Thelidium*, by the juxtaposition of the appropriate algæ and fungi, may almost be regarded as deciding the question. Sachs, in the last edition of his 'Lehrbuch,' has carried out completely the principle of classification of algæ, first suggested by Cohn, and has proposed one for the remaining thallophytes, which disregards their division into fungi and algæ. He looks upon the

former as standing in the same relation to the latter as the so-called saprophytes (e.g. *Neottia*) do to ordinary green flowering plants.

This view has especial interest with regard to the minute organisms known as *Bacteria*, a knowledge of the life-history of which is of the greatest importance, having regard to the changes which they effect in all lifeless and, probably, in all living matter prone to decomposition. This affords a morphological argument (as far as it goes) against the doctrine of spontaneous generation, since it seems extremely probable that just as yeast may be a degraded form of some higher fungus, *Bacteria* may be degraded allies of the *Oscillatoria*, which have adopted a purely saprophytal mode of existence.

Your 'Proceedings' for the present year contain several important contributions to our knowledge of the lowest forms of life. The Rev. W. H. Dallinger, continuing those researches which his skill in using the highest microscopic powers and his ingenuity in devising experimental methods have rendered so fruitful, has adduced evidence which seems to leave no doubt that the spores or germs of the monad which he has described differ in a remarkable manner from the young or adult monads in their power of resisting heated fluids. The young and adult monads, in fact, were always killed by five minutes' exposure to a temperature of 142° F. (61° C.), while the spores germinated after being subjected to a temperature of 10° above the boiling-point of water (222° F.).

Two years ago, Cohn and Koch observed the development of spores within the rods of *Bacillus subtilis* and *B. anthracis*. These observations have been confirmed, with important additions, in these two species by Mr. Ewart, and have been extended to the *Bacillus* of the infectious pneumo-enteritis of the pig, by Dr. Klein; and to *Spirillum* by Messrs. Geddes and Ewart; and thus a very important step has been made towards the completion of our knowledge of the life-history of the minute but important organisms. Dr. Klein has shown that the infectious pneumo-enteritis, or typhoid fever of the pig, is, like splenic fever, due to a *Bacillus*. Having succeeded in cultivating this *Bacillus* in such a manner as to raise crops free from all other organisms, Dr. Klein inoculated healthy pigs with the fluid containing the *Bacilli*, and found that the disease in due time arose and followed its ordinary course. It is now, therefore, distinctly proved that two diseases of the higher animals, namely, 'splenic fever' and 'infectious pneumo-enteritis,' are generated by a *contagium vivum*.

Finally, Messrs. Downes and Blunt have commenced an inquiry into the influence of light upon *Bacteria* and other fungi, which promises to yield results of great interest, the general tendency of these investigations leaning towards the conclusion that exposure to strong solar light checks and even arrests the development of such organisms.

The practical utility of investigations relating to *Bacillus* organisms as affording to the pathologist a valuable means of associating by community of origin various diseases of apparently different

character, is exemplified in the 'Loodiana fever,' which has been so fatal to horses in the East. The dried blood of horses that had died of this disease in India has been recently sent to the Brown Institution, and there afforded seed from which a crop of *Bacillus anthracis* has been grown, which justified its distant pathological origin by reproducing the disease in other animals. Other equally interesting experiments have been made at the same Institution, showing that the 'grains' which are so largely used as food for cattle, afford a soil which is peculiarly favourable for the development and growth of the spore filaments of *Bacillus*; and that by such 'grains' when inspected, the anthrax fever can be produced at will, under conditions so simple, that they must often arise accidentally. The bearing of this fact on a recent instance in which anthrax suddenly broke out in a previously uninfected district, destroying a large number of animals, all of which had been fed with grains obtained from a particular brewery, need scarcely be indicated." *

Method of representing an Object from Microscopic Sections.—Whilst working on the central nerve system of the crayfish, Herr Krieger, of Leipzig, adopted the following method of obtaining as clear a view as possible of the internal structure.

The ganglia, after being hardened and stained, were imbedded in paraffin, and cut by the microtome into a series of transverse sections. For every section the position of the object-slider was read off on the scale of the microtome. When a satisfactory series of sections had been made, they were drawn with a camera, and the different tissue-elements (ganglia-cells, nerve-fibres, &c.) were marked out with different colours. Then a millimetre scale was drawn with the same amplification, and a sheet of paper ruled with parallel lines whose distance apart, according to this scale, was equal to the thickness of the sections. Each of the drawings was then orthographically projected on to a straight line drawn parallel to the transverse axis of the section, and, when the direction of the cut was exactly at right angles to the longitudinal axis of the object, each projection, according to its place as determined by the readings of the microtome scale, was marked off between the parallel lines in such a manner that the middle points of the projection (symmetrical on both sides) fell on a straight line drawn at right angles to the parallel lines. Nothing more has now to be done but to connect together the points of the projections corresponding to the outlines of the various structures, and by slight shading, &c., to distinguish between those lying higher or deeper, in order to get a representation of what the object would look like if it were perfectly transparent and were viewed from above. If the direction of the cut is not exactly at right angles to the longitudinal axis of the object, we must determine, by comparing the unsymmetrical halves of the section with those of the preceding and following ones, the angle of the symmetrical plane to that of the direction of the cut—draw the central line so that it forms this angle with the parallel lines, and mark off the projections as before.

* 'Proc. Roy. Soc.,' vol. xxviii. p. 43.

By horizontal and sagittal sections, as also by measurements of the drawing and the uncut object, the results obtained may be checked.

Though this plan may seem somewhat tedious, the author says that the result repays the trouble, as so plain a view of the object examined could not easily be obtained in any other way.*

Microscopy at the Paris Exhibition.—It seems to be agreed by those who visited this Exhibition that there was literally nothing new or calling for special remark either in Microscopes or accessories. Microscopes were included in Class 15, "Instruments of Precision," whilst Class 8, "Methods and Material of Higher Education," contained most of the Microscopic preparations exhibited, some of which were also included in Class 14, "Medicine, Hygiene and Public Assistance;" Class 12, "Photographic Apparatus and Photographs," contained Micro-photographs. The jurors in Class 15 were Lord Lindsay (for England), MM. Bardoux, Cornu and Laussedat, and Commandants Mouchez and Perrier (for France); Dr. Fleischl (for Austria-Hungary); Signor Colombo (for Italy); M. Broch (for Sweden and Norway); and M. Soret (for Switzerland).

We have endeavoured to compile a list of the gold, silver, and bronze medals and honourable mentions awarded to opticians and others for Microscopes, &c.; but as these were not separately classed, it is impossible to distinguish with complete accuracy the cases in which the award was made for Microscopes, or for some of the other instruments exhibited in conjunction with them. The difficulty would obviously not be solved by taking the names of those opticians who are makers of Microscopes only, and under these circumstances we must leave the official list to speak for itself.

The Generation of Gas in the Protoplasm of living Protozoa.—The discovery that gas is generated in the protoplasm of *Arcella* under the influence of volition, and serving for a hydrostatic purpose,† gave rise to the conjecture that other Protozoa living free in water might be able to make use of this simple means of vertical motion. Professor T. W. Engelmann says‡ that his occasional attempts to confirm this supposition have led to a positive result in at least two instances.

He found on the surface of some water which was taken from a ditch richly covered with duckweed, a spherical *Sphærophrya*, measuring .08 mm. which contained a large air-bubble. The species was distinguished by its size, and also by thirty to forty relatively very long (.12 mm.) and thin suctorial filaments regularly spread over the surface of the body; and also by numerous small contractile vesicles placed at some distance under the cuticle. It may be called *Sph. hydrostatica*. When the animal came to be examined, the air-bubble occupied about the fourth part of the volume of the body, it was situated immediately under the cuticle, and had in a tangential direction a long oval shape. In four minutes it disappeared, decreasing very gradually, and at the same time becoming

* 'Zoologischer Anzeiger,' vol. i. p. 369.

† See Pflüger's 'Archiv für die ges. Physiologie,' vol. ii.

‡ 'Zoologischer Anzeiger,' vol. i. p. 152.

more irregular and angular. The protoplasm meantime advanced from within towards the cuticle, which sank in somewhat and became folded. The original spherical form of the animal became very sensibly flattened. Attempts to produce a fresh generation of gas unfortunately could not be made.

The second case relates to a form allied to, if not identical with *Amœba radiosa*. It was obtained by a pipette from the surface of some water pretty thickly covered with *Lemna*. Amongst several specimens one was found which measured about $\cdot 15$ mm., and was furnished with about twenty short, irregular, and pretty broad conical protuberances, which in the interior contained a perfectly spherical air-bubble about $\cdot 05$ mm. in diameter. This continually diminished from the moment the animal came to be examined. Within three minutes it had disappeared, and he did not succeed in observing a new generation of air.

Since, therefore, the presence of gas-bubbles in living protoplasm has been confirmed in three forms of Protozoa lying widely apart from each other, it may be considered probable that the phenomenon is still further extended; but as he is only seldom in a position to pay attention to the subject, Professor Engelmann asks those of his fellow explorers in the same field, who have more frequent opportunities, to investigate the matter. Success would doubtless be best attained if the animals are taken from the surface of the water and examined as quickly as possible.

On this communication Professor Géza Entz, of Hungary, writes: *—"Referring to the account given by Professor Engelmann of the interesting phenomenon of gas-bubbles in the protoplasm of Protozoa swimming on the surface of water, I have had an opportunity of observing it, not only in *Arcella* and *Amœba*, in which (especially the former) it occurs with great frequency, but several times in *Difflugia proteiformis* also. The latter had always only one, but that a very large gas-bubble, occupying almost half the body; it gradually diminished whilst under examination, finally disappearing without leaving any trace: the *Arcella* and *Amœba*, on the other hand, often had several bubbles. Once I observed in an *Arcella* a bubble between the shell and the body of the rhizopod, which forced itself to the mouth of the shell and finally out from beneath it, like an air-bubble out of a submerged tilted bell. It should be observed that the generation of gas in the protoplasm of *Amœba* and *Arcella* was observed thirty years ago by Maximilian Perty, who gave the same explanation of the phenomenon as Engelmann."

Sperm-formation in Spongilla.—The presence of corpuscles of a zoospermatic nature in *Spongilla* appeared, says Dr. C. Keller,† from Lieberkühn's researches in 1856 to establish as an assured fact the existence of a sexual differentiation in the sponges. Since then, however, the investigation of marine sponges has so seldom succeeded in showing the spermatie elements, that recently serious doubts have been raised in influential quarters as to the sexual differentiation—

* 'Zoologischer Anzeiger,' vol. i. p. 248.

† Ibid., p. 314.

doubts which must certainly now be considered completely disposed of after the proof of the separation of the sexes in *Halisarca* and in *Aplysilla sulfurea*, where, according to F. E. Schulze's investigations, male and female elements occur. Further observations may serve to give greater weight to Schulze's statement.

Dr. Keller endeavoured last year to examine the facts in question in *Spongilla*. A separation of the sexes seems to occur in this fresh-water sponge also—at least, he found all through the summer small specimens which contained neither eggs nor larvæ, but, on the contrary, were closely filled, especially in the spring, with sperm-follicles in the most varied stages of development. The smaller specimens were attached to the cases of the larvæ of *Phryganea*, and in these were found almost invariably sperm-balls. It is just these which must be especially adapted for fecundation.

The spermatic elements are enclosed in a special receptacle, and when mature move about in it with great activity.

Each follicle is surrounded by numerous cells (nutritive migratory cells). If a mature follicle bursts, or if it is made to burst by pressure on the covering glass, the sperm-cells disperse, and move about in large numbers (their heads disposed towards each other) for hours at a time with great briskness.

In the younger follicles the movement is wanting; the contents are numerous closely-pressed round elements. It is to be assumed in the case of *Spongilla*, therefore, that the sperm-follicle with its contents originates from a single cell by continual division.

These are recommended as a desirable object for demonstration in a course of zootomy, as the movements in the follicles last a considerable time. The small *Spongilla* found attached to the cases of *Phryganea* in May and June are the best adapted for this purpose.

The exact Orientation of the principal Section of Nicols in Polarizing Apparatus.—It is sometimes necessary to be able to determine the orientation of the principal section of the polarizers and analyzers—Nicols, double refracting prisms, &c.

It may be done simply and with precision by illuminating the apparatus, in order to adjust it, with yellow light, and interposing a diaphragm between the polarizer and analyzer, one-half of it being covered with a half undulation plate of thin quartz parallel to the axis.

This diaphragm can always be put in position. Polarizing apparatus generally have either a system of lenses or a single lens, which can then be used to view the diaphragm. If this is not the case, a small auxiliary lens can be used. The interior margin of the plate separates the two half-disks, and produces a well-defined line.

Let us suppose that it is required to fix a Nicol so that its principal section shall make a given angle with certain reticular threads, &c. The problem is reduced to placing the margin of the plate in the desired position, and, as this is a well-defined line, the optical and mechanical means are not wanting.

The Nicols are then adjusted with respect to the plate. To do this, the polarizer is placed so that its section is *approximately* in the

required direction, and the analyzer is turned a few degrees to the right and left. Two cases then present themselves:—

1. If this section is *by accident* exactly in the required position, the transition from partial to total extinction will be gradual, and no difference in intensity will be perceived between either of the two half-disks in any position of the analyzer.

2. If the section of the polarizer is not exactly in position, if it makes even an excessively small angle with the line of separation, variable differences will be found between the two half-disks.

If the analyzer is stopped in a position near to total extinction, one half-disk will be seen to be darker than the other; the polarizer should then be turned gradually till equality in tint is established, and that will be the position sought. This should be tested by turning the analyzer, when the two half-disks ought to be found perfectly equal in intensity, this intensity varying with the rotation of the analyzer.

The position of the polarizer is marked; then to determine that of the section of the analyzer the polarizer is gently displaced about $1\frac{1}{2}^{\circ}$, which destroys the equality of the intensities; this is afterwards restored by the analyzer. The principal section of the latter will be found at exactly 90° from this last position.

This method can also be used to determine the principal sections of quarter and half undulation plates, and that of plates parallel with the axis. It gives much greater precision than the ordinary methods.

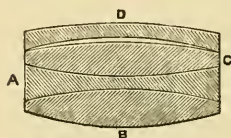
The margin of the half-plate, which separates the two half-disks, is perfectly clear, and without thickness; we have then to compare two surfaces of different intensities which are *strictly tangent*. If the adjustment is made with care, the slightest difference will be appreciable; and this detail contributes much to increase the precision of the method.*

Improvements in Object-glasses.—Mr. Gundlach, of Rochester, New York, has patented a method of constructing object-glasses for astronomical telescopes and other purposes, by which both aberrations are corrected to a higher degree than has hitherto been attained. The common double objective, consisting of a negative flint-glass lens and positive crown-glass lens, is deficient by reason of chromatic over-correction at the outer edge, and chromatic under-correction towards the centre. This is caused by the flint-glass lens, as usually shaped, not having the proper form to remove this defect. Nor can it be perfectly removed by any alteration in shape, except at the expense of increased spherical aberration, the correction of both aberrations depending on the same factor (the flint-glass lens), and on opposite conditions of this factor, the best form for the complete correction of the one producing the maximum of the other aberration.

The difficulty is obviated by constructing an object-glass, in which both the chromatic and the spherical aberrations are corrected by special means independent of each other, leaving the flint-glass lens to perform exclusively its legitimate function of correcting the

* M. L. Laurent, in 'Comptes Rendus,' vol. lxxxvi. p. 662.

chromatic aberration without reference to the spherical aberration, and correcting the latter by one or more negative crown-glass lenses of the proper focal relations to the others. The accompanying drawing represents a cross section of the object-glass. A is the double concave flint-glass lens; B and C crown-glass lenses, of appropriate



focal proportions; and D an additional negative crown-glass lens, its purpose being the completest correction possible of the spherical aberration. The double concave form is the best for the highest possible correction of the chromatic aberration, the ordinary concavo-convex form having been

adopted only as a compromise aiming at the correction of both aberrations at the same time, which can only be imperfectly attained under such circumstances. By this means the objective can be made almost absolutely achromatic, leaving the spherical aberration to be corrected by other and independent means, viz. by the special negative crown-glass lens, D (or, if preferred, more than one), concavo-convex in shape, the concave surface of which has a shorter radius than the convex surface of the positive crown-glass lens next to it, so that between the two a space remains in the shape of a meniscus.

The loss of illuminating power on account of the increased number of surfaces can be reduced to a minimum by cementing the adjoining surfaces; the loss being further reduced in comparison with a double object-glass by having the outer surfaces consisting of crown glass, the loss of light on such surfaces being less than on flint-glass surfaces. It will, moreover, be preponderatingly compensated by the better correction of the aberrations and the greater clearness and sharpness of definition resulting therefrom.

British Acari—Oribatidæ.—Mr. A. D. Michael has sent a paper to the Society (which cannot be published yet for want of space) giving the results of his researches among British *Acari* of the family *Oribatidæ*, conducted during the past year in conjunction with Mr. C. F. George. Forty-four species have been found, of which only three or four have been previously recorded as British. Of these forty-four species, three are believed to be entirely new, viz. two species of the genus *Tegeocranus* which Mr. Michael proposes to call respectively *T. labyrinthicus* and *T. elongatus*, and one which he proposes to make the type of a new genus to be called *Scutovertex*, the species being called *sculptus*. The new species are fully described and figured. The life-history of *Tegeocranus latus*, *Nothrus theleproctus*, &c., of which the larvæ and nymphs were not previously known, have been traced, and are described and figured.

The Structure of the Nerves in the Invertebrata.—The histological characters of the nerves, whilst determined with precision for the Vertebrata, are imperfectly known in the other divisions of the animal kingdom. Their exact determination is nevertheless important from all points of view, for the examination of the external form alone is insufficient when we wish to know if such or such part among inferior

animals, among the *Radiata* particularly, belongs or not to the nervous system. Certain authors, moreover, have taken their stand on the differences which the nerve elements present in Invertebrata and Vertebrata to mark further the separation which exists between these two divisions of animals.

The nerves of Decapod and other Crustacea, in spite of their bulk, are difficult to study, by reason of the rapidity with which these elements alter when they are isolated or dead, or are brought into contact with any reagent. The nerves of the ganglionic chain and the peripheral nerves present identical characters. They are formed by bundles of nerve-tubes enveloped in a sheath of very thick perineurine.

Each of these tubes is composed of a *sheath* of a homogeneous amorphous substance, the contents of which are soft, easily changeable, sometimes homogeneous, sometimes either finely granular, or striated longitudinally. These tubes are very voluminous. Their diameter varies from .01 mm. to .08 mm. and .09 mm. Notwithstanding that, all the cylinder of the substance or soft fibre which fills the amorphous sheath of the nerve-tubes of the Crustacea corresponds to the single *cylinder-axis* of the nerve-tubes of the Vertebrata, an idea already propounded, but in a rather doubtful manner, by Leydig. The myeline is wanting, and its absence leaves the essential microscopical filaments of the nerves with their transparency and their paleness, whence the difficulty of seeing them by transmitted light as with the naked eye. Our * researches show that there is identity of substance between the cellular body of the ganglionic cells and the contents of the nerve-tube starting from the ganglia. 1st, the large cells of the ganglia which attain the size of one-fifth to one-fourth of a millimetre, have prolongations very nearly as large as the largest peripheral nerve-tubes into which we succeeded in following them, as so many fibres filling the tube or homogeneous sheath; 2nd, immediately after death sarcodic atoms are formed in the cells and in the substance of the nerve-fibres, gradually bringing about the decomposition of both into granular masses of identical appearance; 3rd, nitric acid, alum, and perchloride of iron produce at the same time coagulation of the body of the cells and the contents of the tubes. Nitric acid, particularly, gives an absolutely conclusive reaction; it retracts the substance of the nerve-fibres, and produces a very distinct and regular longitudinal striation; the same striation is seen on the cells and their immediate prolongations.†

* M. Cadiat, in 'Comptes Rendus,' vol. lxxxvi. p. 1420.

† This is difficult to demonstrate among the Vertebrata; and it has been sought for in many ways, because it is important to physiology to know if each cylinder-axis is a bundle of nervous conductors. In the Crustacea, particularly in the *Maia squinado*, this situation is very evident. On the ganglionic chain of larva of *Libellula* are found nerve-tubes identical with those of the Crustacea. But, in the insects, the sheaths of Schwann are very fine and fragile, and under the influence of the least pressure or of a liquid having sufficient osmotic power, all the tubes enclosed in the same sheath of perineurine break and leave a granular residue scattered over with nuclei. This granular matter, under the influence of alum and carmine, takes exactly the same tint and the same appearance as the masses which surround the nucleus of the nerve-cells. In the Leech, *Dytiscus*, and *Hydrophilus* we have obtained analogous results.

To sum up; among the Crustacea, the Insecta, and the Annelida, the structure of the nerves differs from that of the Vertebrata by the complete absence of the substance endowed with great refractive power, called *myeline*, which in these latter is interposed between the cylinder-axis and the proper wall of the tube, the grey fibres of the great Sympathetic excepted.

In the Gasteropodous and Acephalous Molluses the nerves are further simplified; the sheath proper, or sheath of Schwann, is wanting in almost all the nerves. The *nerve-tubes* only, represented by the *cylinder-axis*, form bundles which it is difficult to dissociate.

One more character remains yet to be added to those which we have referred to. The nerve-cells of Crustacea were of an extreme fragility. The contents of their tube are displaced very easily. In the snail the cell takes a certain consistency. The cylinder-axis of the nerves opposes also more resistance to pressure and to chemical agents.

The author adds in a further foot-note:—In the Bryozoa we have observed a nerve layer situated under the ectoderm. This layer was composed of cells very distant from one another, and united by bundles of rectilinear filaments possessing small oval nuclei in their thick part, resembling those which are formed in the nerve-fibres during development in all animals. From this sort of plexus start very fine threads which extend along the tentacles, others go to the retractor muscle. The characters observed in the nerve-tubes of all the animals which we have passed in review allow us to conclude that the cells with the filaments which depend from them, and which we have seen in the Bryozoa, are truly nerve elements. Here, the nerves, closely allied in their structure to those of the Molluses properly so called, would be reduced to the *cylinder-axis*.

Development of Cephalodia on Lichens.—M. Babikof has undertaken some investigations with the view of settling the origin of the peculiar excrescences found on the surface of some lichens, known as *Cephalodia*. The result is contained in a paper* presented to the Imperial Academy of Sciences of St. Petersburg.

The author says that the structure of the cephalodia is known in a small number of lichens only, and that there are but few exact notions as to their development-history. Some hypotheses, very probably correct, have been suggested, but they have not yet been established by facts. A summary is given of the views of Messrs. Nylander, Th. Fries, Schwendener, and Bornet, on the cephalodia of *Stereocaulon*, and it is pointed out that what they have observed has been simply different degrees of development of the alga by the hypha, and not the complete progress of the development of the cephalodia.

“It is therefore only in consequence of simple isolated facts that the authors have supposed that the cephalodia are abnormal formations produced by a local growth of the lichen under the influence of alga accidentally fallen upon it. Their hypothesis has, however, been completely confirmed by experiments which I have made under the guidance of Professor A. S. Famintzin, on the development of the

* ‘Bull. de l’Académie des Sciences de St. Petersburg,’ vol. xxiv. p. 548.

cephalodia of *Peltigera aphthosa*, which I have followed from the first commencement of the invasion of the alga by the hypha up to the complete development of the cephalodia."

After a reference to the description given by Acharius of the cephalodia in question, the author thus details his own investigations.

In vertical sections of a cephalodium of *Peltigera aphthosa* completely developed, the central part consisted of a tissue of filaments loosely interlaced with hypha, between which were masses of bluish gonidia, arranged without any apparent order, whilst the periphery was formed of a homogeneous brown cortical layer, much thicker on the superior side than on the inferior, and consisting of pseudo-parenchymatous tissue. From the inferior surface descend a row of radical hairs (rhizines) of a dark brown, of which the membranes, very much thickened, penetrate to the soil through the openings of the thallus of *Peltigera* and interlace themselves with the similar hairs of the latter. The body itself of the cephalodium is in contact with the edges of the opening of the thallus, like a cover, and without any organic relationship with it. If the general form of the cephalodium were examined, without knowing the history of its development, we should suppose that it must be a homeomerous lichen growing parasitically on the *Peltigera* and bearing a resemblance to *Pannaria triptophylla*, for example. The gonidia of the cephalodia are blue, and consequently belong to the phycochromaceous algæ; whilst those of the lichen itself are of a light green and belong to the chlorophyllaceous. They are also distinguished from one another by their size; the former attain $\cdot 010$ mm., the latter only $\cdot 006$ mm. Both are oblong, often triangular or square, but rarely round. In examining the form of the gonidia of the cephalodia it is impossible to decide to what algæ they belong.

To solve this question, the author took advantage of the method of culture employed by MM. Famintzin and Baranetsky, in their researches on the gonidia of *Collema pulposum* and *Peltigera canina*, and sowed in soil previously boiled some sections of cephalodia (examined under the microscope to assure the absence of any foreign organism), and then placed under a bell-glass in a damp atmosphere. At the end of two weeks and a half, when the hyphæ were entirely destroyed, there could be remarked on the surface of the sections a great number of small gelatinous balls, each containing three or four bluish cells. After another week the little balls acquired more considerable dimensions, and the number of bluish cells increased; at the same time these latter were found arranged in small doubled up chains, of which some already contained heterocysts characteristic of *Nostoc*. Five weeks after the sowing colonies of perfectly formed *Nostoc* were found, which consisted of numerous little chains, with completely developed heterocysts; the little chains were imbedded in a mucilage bounded by very distinct outlines. The cultivation of the gonidia proved therefore that they originated from the *Nostoc*, entirely changed in form under the influence of the invasion of the hypha.

Being desirous of knowing in what manner perfectly free *Nostoc*

had degenerated into gonidia and had given rise to the formation of the cephalodia, the author examined the history of the development of the latter with the following results:—

On the surface of the thallus of *Peltigera aphthosa* are found verrucose cephalodia, which, as they approach the edge of the lichen, become smaller and at last appear to the naked eye like a grain of dust. The smallest are the youngest. Amongst these excrescences is often found a bluish coating, which consists exclusively of *Nostoc* in different degrees of development; they are rarely found mixed with other algæ. By making transverse sections of the youngest portions of a perfectly fresh lichen, it may be seen under a high magnifying power that its surface is covered with a great number of hairs, formed of one, two, or three cells; among these hairs are often found whole colonies of *Nostoc*, some of which are entirely free, simply in contact with the surface of the hairs, and easily separating from them under the pressure of the covering glass; others, on the contrary, are so closely attached to the hairs, that it is only by very strong pressure that they can be detached, and then only by removing the hair at the same time. The hairs connected in this manner with the colonies, undergo a division into numerous cells, and put out little branches which penetrate into the interior of the mucilage and wind about among the filaments of the isolated *Nostoc*. This is the beginning of the formation of the cephalodia. In the same sections, or in others made on older portions of the lichen, colonies of *Nostoc* are met with where the interlacing by the hypha begins. We see distinctly that some of the branches insinuate themselves into the interior of the mucilage, whilst others only touch the surface and give rise to the cortical layer by forming numerous lateral branches which adhere to one another. At this period the cortical layer does not cover the whole surface of the colony; the mucilaginous substance, which has become darker, is seen projecting here and there, and in the interior the cells of *Nostoc* spread themselves, no longer arranged in the form of isolated filaments, but united into a compact mass. If this preparation is broken up, there will be seen, amongst the cells of *Nostoc*, filaments of hypha which start from the cells of the cortical layer. In sections made on an older portion of the lichen, colonies of *Nostoc* are found entirely interlaced by hypha, where the cortex is formed of a continuous layer of cells, arising from the ramification and their reciprocal adherence. At the first glance such formations might be taken for the fructifications of *Pyrenomyces*, if the history of their development, as well as their anatomical structure, were not already known.

In proportion as the invasion of the *Nostoc* by the hypha becomes complete, the cells of the cortical layer of the lichen and the hyphæ of the gonidial layer rise considerably in their growth, and gradually form with the cephalodium a continuous tissue. The gonidia of the lichen, which are found below the cephalodium, perish and disappear gradually, being absorbed by the surrounding tissue; moreover they are no longer arranged in a continuous layer, but an intermittent one. In its more advanced stage, the cephalodium increases considerably in a direction parallel to the surface of the lichen and takes a lenticular

form. It is in this stage that it is described and figured by Acharius (t. x. f. 8). When the cephalodium so increases, the tissue of the lichen under it no longer appears in the form of pseudoparenchymatous cortex, and no longer encloses gonidia, but consists only of hyphæ very much interlaced, and it is only on the parts placed near the borders of the cephalodium, that there can still be observed a progressive transition of the round cells of the cortex into the completely developed filaments of the hypha, which degenerate progressively into radical hairs (rhizines) of a dark brown colour. As soon as the final transformation of the tissue of the bark of the lichen into filaments of hypha is accomplished, all connection between the cephalodium and the thallus of the lichen disappears. At the point where the separation of the cephalodium has taken place, the cells of the cortical layer of the lichen assume a brown hue; below them extends a layer of gonidia which, whilst it touches some of the radical hairs of the cephalodium, has no longer any connection with them. Under the layer of the gonidia of the thallus is arranged the medullary layer, whose filaments are clearly distinguished from the radical hairs by their more transparent colour, as well as by the thickness of their membrane. The cells of the hypha of the cephalodium, disposed under its gonidia, having degenerated into radical hairs, are transformed into pseudoparenchymatous cortex which covers its inferior face. As soon as the cephalodium becomes entirely independent of the lichen, it grows more and more horizontally, and finally receives the oblong, or orbicular and flattened form.

We may conclude that the cephalodia owe their origin to the parasitic nature of *Nostoc*, which is always found in damp places, where the lichen is usually met with. Not that the *Nostoc* alone takes part in the formation; other algæ also share in it perhaps, as Schwendener and Bornet have shown in *Stereocaulon*. It is possible, that if *Peltigera aphthosa* were gathered in some other locality, other algæ than *Nostoc* might perhaps also be found. A coloured plate of nine figures accompanies the paper.

Mr. Sorby's New Micro-spectroscope.—This instrument, which was briefly noticed in its original form at page 148 of vol. i., has since been modified and improved, and was exhibited at the meeting of the Society, on 8th January.

The principal advantages of the instrument are the small size (half the ordinary size) combined with great dispersive power and excellent definition, with large field of view over the whole spectrum.

To obtain this, a change in the ordinary mode of construction has been adopted, the achromatic object-glass focussing the slit being placed, not below the prism as usual, but above it, close to the eye. A much longer focus can therefore be obtained for the object-glass, and consequently better definition. To collect the light coming from the slit, a cylindrical lens is fitted behind the prism and gives an even, bright light far into the extreme ends of the spectrum, so that no shifting of slit or micrometer arrangement is required. Without any trouble of re-adjustment the object-glass also focusses a micrometer scale which extends over the whole spectrum, and consequently

wave-lengths can be read off with ease in every part. The comparison prism is placed at right angles to the line of the slit, and enables both spectra to be focussed sharply at one and the same time.

Mr. Hilger, by whom it is made, calls it "the Miniature Microspectroscope."

The Structure of Blood-vessels.—Ranvier* has described peculiar spindle-shaped extensions in the blood-vessels of the red muscles of rabbits—a kind of small aneurism. They are found in the capillaries, especially where they merge into each other, and in small veins. These extensions, according to Ranvier, are the reservoirs for blood, from which the muscles at the moment of contraction draw oxygen.

These extensions of the blood-vessels are not only found in red muscle, but also in other contractile tissues. Professor P. Peremeschko says † that he has found them finely developed in the Lig. nuchæ of dogs and cats. They are situated chiefly in the capillaries, but also in small arteries and veins. Their number is much more considerable here than in muscle; they are often placed in one and the same vessel in rows alongside of each other, so that the injected vessel assumes the form of a string of pearls. Their shape is sometimes spindle-like, sometimes oval, sometimes quite round. In young animals their length and thickness and number are less than in full-grown animals. In embryos during the first half of gestation they are entirely wanting, and appear only at the end of that period in the form of scarcely recognizable thickening of the vessels.

Borings of a Sponge in Marble.—Some fragments of white Italian marble were recently presented to the Peabody Museum of Yale College, U.S. The marble was part of a cargo wrecked off Long Island in 1871, and taken up in 1878. The exposed portions of the slabs were thoroughly penetrated to the depth of one to two inches by the crooked and irregular borings or galleries of the sponge *Cliona sulphurea*, Verrill, so as to reduce it to a complete honeycomb, readily crumbling in the fingers. Beyond the borings the marble was perfectly sound and unaltered. The rapid destruction of the shells of oysters, &c., by the boring of this sponge has, Mr. Verrill says,‡ been long familiar to him, but of its effects upon marble or limestone he has not before seen examples; for calcareous rocks do not occur along the portion of the American coast which it inhabits. Its ability to rapidly destroy such rocks might have a practical bearing in case of submarine structures of limestone or other similar materials.

Alcoholic Fermentation.—M. Pasteur has carried out his intention of making a critical examination of the MSS. of the late Claude Bernard,§ which M. Berthelot stated contained a refutation of M. Pasteur's theories. The result of this examination is published in No. 22 of the last volume of the 'Comptes Rendus,'|| where it occupies

* 'Arch. de Physiol.,' 1874, t. 1.

† 'Zoologischer Anzeiger,' vol. i. p. 200.

‡ 'Am. Jour. of Sci. and Arts,' vol. xvi. p. 406.

§ See vol. i. p. 271.

|| 'Comptes Rendus,' vol. lxxxvii. p. 813.

six pages. M. Pasteur describes the MSS. as "one of the most curious revelations possible of the influence of a defective system on a person extremely exact and given to rigorous experimentation. It is a sterile attempt to substitute for well-established facts the deductions of an ephemeral system. The glory of our illustrious confrère cannot be diminished by it. The errors of those who have accomplished a valiant career have only the philosophic interest which belongs to the recognition of our human weakness. Men are great only by the services which they have rendered, a maxim which I am happy to borrow from Bernard's last words."

Dry Preparations of Diatoms, &c.—Although there are many processes for making balsam preparations of very thin objects which are required to be placed in the most favourable position for observation, or in a particular order, yet few are able to accomplish this readily in the case of dry preparations except M. Möller, whose process is a secret.

The following is said by M. G. Marmod in the 'Journal de Micrographie'* to be a very simple method. Heat a small quantity of oil of cloves, and expose a slide to the vapour until there is deposited on the slide a series of very small drops. These drops take an hour or two to evaporate completely, and there is therefore plenty of time to arrange the diatoms or other objects, which will remain after the evaporation solidly fixed and without deposit.

The Organs of Attachment of Stentors.—From an examination of *Stentor caruleus*, Professor A. Gruber has succeeded † in finding out how these animals effect an attachment to foreign objects. He agrees with Stein ‡ that a suckorial disk is never found, although sometimes a slight disk-shaped depression is seen at the posterior extremity of the body, but disagrees with Stein's further statement, that the attachment is effected by means of "very fine pseudopodia-like processes" of the sarcode, which radiate thickly from the posterior pole of the body and appear like a skein of elongated bristle-shaped cilia. No structure of that kind was found in *S. caruleus*, though vibratile cilia were seen which were longer than the rest, and which doubtless gave rise to Stein's description.

In all Stentors there are to be found immediately after they have detached themselves, variously shaped small appendages at the posterior extremity of the body, which on closer examination prove to be amoeboid processes of the sarcode. When the animal has no opportunity of attaching itself these processes disappear, for the most part somewhat rapidly, after repeatedly changing their form, and the end of the pedicle appears uniformly rounded. On the other hand, in the case of an animal which has found an object to which it can attach itself, it is seen that the processes, mostly finger-shaped or drawn out into fine pseudopodia, are clasped round the object.

If the view of Stein were correct, that the muscle-stripes of the

* 'Journal de Micrographie,' vol. ii. p. 506.

† 'Zoologischer Anzeiger,' vol. i. p. 390.

‡ 'Der Organismus der Infus,' II. Abth. p. 224.

Stentor are continued to the posterior pole of the body, it would be difficult to conceive how these fluid amœboid processes could be formed from the cortical layer to which the muscles belong. Gruber saw, however, that the muscle-stripes do not converge to the pole, but that a small space, which forms the posterior extremity of the body (probably the disk-shaped cavity of Stein) remains free from them.

Here the structureless sarcode appears therefore in its natural state, as can be seen when the part is viewed from above. Though this in different states of contraction may change very much in size or even almost disappear, yet it always is there and can send out pseudopodia at any moment. In this way an explanation is found as to how these amœboid processes originate, which render it possible for the Stentor to attach and again detach itself at will.

A new Method of preparing a Dissected Model of an Insect's Brain from Microscopic Sections.—At the meeting of the Quekett Microscopical Club of the 24th January, Mr. E. T. Newton described a very ingenious method which he had devised. The brain modelled was that of the common cockroach (*Blatta orientalis*), and the method was as follows:—The brain properly hardened was cut up into a consecutive series of slices, each being mounted and numbered. An enlarged drawing of each section was then made with a camera lucida, and these drawings transferred to pieces of wood of a thickness proportionate to the thickness of the sections, and then cut out with a saw. By piling together in their relative positions this series of slices of wood and trimming off the angles, a model of the external form of the brain was produced which can be taken to pieces so as to show the drawings of the sections upon their faces. The series of slices which make up the right half of the brain were then taken and the more important structures in each cut out like a child's dissected map puzzle. The corresponding structures were taken from each slice and fixed together in their relative positions, in such a manner that the whole may be fitted together, and when desired the more important parts may be, as it were, dissected out. The President (Professor Huxley) highly commended the ingenuity of the method and the manner in which it had been given effect to in the model—an expression of approval which was fully endorsed by the meeting.

The Relations of Rhabdopleura.—This singular Polyzoal genus was the subject of a communication by Professor Allman, Pres. L. S., at the meeting of the Linnean Society of the 19th December. He maintains that the endocyst, hitherto supposed absent, is really represented by the contractile cord which seems to take the place of the funiculus in the fresh-water Polyzoa. In Rhabdopleura the endocyst has receded from the ectocyst, and its wall approximation and nearly complete obliteration of cavity has become changed into the contractile cord. Anteriorly it spreads over the alimentary canal of the polypide, to which it becomes closely adherent, and here represents the tentacular sheath. Posteriorly the endocyst undergoes greater modification, the contractile cord becomes chitinized, and converted into the firm rod which runs through the stem and branches over all the older parts of the colony, and which still presents in its narrow lumen a trace of

the original cavity of the endocyst. The very remarkable shield-like appendage which is attached to the lophophore G. O. Sars regards as epistome. Professor Allman traces its development as a primary bud from the modified endocyst, and it again budding the latter finally becomes the definitive polypide, while the primary bud remains as but a subordinate appendage. We have thus in *Rhabdopleura* an alteration of heteromorphic zooids.

Formation of Ovisacs in Copepoda.—In a recent work (on two fresh-water Calanidæ) Dr. Gruber, of Freiburg, in Baden, expressed the conjecture that in some Copepoda the secretion for the formation of the peculiar (so-called) ovisacs consisted in part of the emptied contents of the adherent spermatophore. He now finds* that this is not so, as he intends to show in a subsequent publication on the structure of the sexual organs and the reproduction of Copepoda. The secretion originates, as is seen in *Diaptomus*, in the oviduct itself, and is forced out by the eggs on their exit through the sexual opening, and, being hardened in the water, forms the sac. He has also demonstrated the existence of a secretion in *Cyclops* filling the oviduct up to the vulva, which certainly has the same object.

The Conidia of Polyporus sulfureus, and their Development.—M. de Seynes† has discovered in *Polyporus sulfureus*, Bull, the presence of secondary organs of reproduction.

A specimen of this fungus, gathered in the forest of Fontainebleau, presented in the superior part of the receptacle, which usually becomes white, a light drab tint and a very evident pulverulent state. Examined under the microscope, the coloured tissue disaggregated into a considerable number of small, rounded, free bodies, composed of an envelope, thick, smooth, and refractive, and with contents consisting almost wholly of an oily homogeneous nucleus, separated from the wall by a thin layer of hyaline liquid. They are spherical, with a tendency to become cruciform or oblong, and measure from $\cdot 005$ mm. by $\cdot 006$ mm. to $\cdot 016$ mm. by $\cdot 019$ mm. A certain number of them are borne by the elongated cells, whose structure is the same as those of the cells which form the pseudoparenchyma of the receptacle. These cells are cylindrical and have a thick refractive wall, sometimes quite obliterating their internal cavity. The ramifications branch off usually at right angles, and they present sudden inflexions; these characters are so clear that they cannot be confounded with any mycelium. We cannot then conclude that we have to do here with a parasitic vegetation originating from the exterior. The situation of these little bodies at the antipodes of the sporiferous tubes on the interior of the receptacle, gives rise to a legitimate comparison with the conidia of the receptacle of *Fistulina hepatica*. Thus we find extended to the genus *Polyporus* an anatomical and physiological arrangement which might seem to be confined to a genus of mixed characters, and exceptional in many respects.

The existence of endocarpous conidia in *P. sulfureus* reveals an unexpected affinity between the Polyporei and the Lycoperdoideæ.

* 'Zoologischer Anzeiger,' vol. i. p. 247.

† 'Comptes Rendus,' vol. lxxxvi. p. 805.

Here we have, in reality, a *Polyporus* of which the receptacle is angiocarpous, like that of the *Gasteromycetes* in the superior and conidian part, and which is gymnocarpous in the inferior and hymenial part. This receptacle becomes dry and brittle; the whole of the conidia in it have at maturity the appearance of a pulverulent gleba much more marked than in *Fistulina*. These elongated cellulose scattered across this sort of gleba, produce the illusion of a capillitium.

The formation of the conidia is successive; it takes place at the extremity of the cellular ramifications; when a conidium has arrived at maturity and is detached, a second is formed below, and detached in its turn. This is the process of development which authors have called "aerosporous"; but here, as in the greater number of similar cases, there is only an illusory appearance. Even on a dry specimen it is easy to recognize the real genesis of the conidia by unequivocal signs, and by the aid of appropriate reagents. In the greater number the envelope is homogeneous and single; we find some, however, especially among the largest ones, which have empty spaces in the thickness of the wall itself; these spaces describe a curve, concentric with the double outline of the wall, and are situated at the two extremities of the longer diameter. They are sometimes united by a dark line which traces thus the separation of two distinct envelopes. We can see that the outlines of the external envelope are continuous with those of the parent cell. When the conidium is still adhering to it, the relatively great thickness of the different walls renders this observation easy and its interpretation very clear. A transversal septum is most often formed below the point at which the conidium develops itself, so as to form a chamber—a sporangium, it may be called—in which the conidium is organized. The wall of the latter adheres early to that of the parent cell, of which sometimes it does not reach the summit; at other times the adherence is interrupted, and even the space comprised between the inferior part of the conidium and the septum of the parent cell is filled with cellulose. The parent cell, impoverished and attenuated below the septum, breaks at this point, and the conidium carries with it the little cellulose appendage which served it as support. Sulphuric acid and the prolonged action of glycerine disassociate the conidium from the parent cell and make it appear free from all adherence in the cellular chamber in which it has had its origin; the preliminary phases of the germination produce the same result.

We have seen above that during the development of the conidium the wall of the parent cell becomes thinned for the benefit of the conidium; the same phenomenon is produced in the successive development of the cells of the receptacle; these facts led the author to examine the influence which is exercised on the properties of the fungoid cellulose by the displacements which it undergoes in the species which take up from the thick walls of their cells the materials for their nutrition and growth. The instability, the diminution of cohesion, doubtless imposed on the fungine by these displacements, seem to account for its property of turning blue on the contact of an iodine reagent, without becoming soluble in Schweitzer's liquid.

It might be said to pass through conditions more nearly allied to starch or to dextrine than to pure cellulose. Observations made on *P. sulfureus* and on several receptacles of Polypori, on *Ptychogaster albus*, &c., have shown the frequency of the blue or red reaction of iodine with fungine, contrary to what has been admitted hitherto. The cause of this apparent contradiction doubtless consists in the physiological phenomena here alluded to. It is worthy of remark that the organs on which was first observed, as a sort of anomaly, the blue reaction of iodine, belonged to the reproductive system, that is to say, to the cellular elements of most recent formation.

Polarizer for the Microscope.—At the meeting of the Physical Society on 9th November, Professor W. G. Adams, the president, explained a simple appliance made by Mr. S. C. Tisley for exhibiting the coloured bands due to interference with thick plates. The bands due to regular reflection and refraction were produced by two thick plates nearly parallel to each other and fixed in a brass box with rectangular apertures on its flat faces so that the light fell on the first plate at an angle of 60° , the whole apparatus being of a convenient size for the waistcoat pocket. The elliptical interference bands, due to the scattering or diffusion of light at a point on the front surface of one of the plates, were shown by means of a precisely analogous arrangement, except that the inclination of the plates to each other was somewhat greater; in this case the interference bands, formed by *regular* reflection and refraction, fall in another direction, so that they are not received by the eye; the diffusion interference fringes obtained were clearly visible when thrown on the screen. They are formed by rays once diffused from points on the first surface and afterwards regularly reflected and refracted from the front and back faces of the two plates in succession. Professor Adams pointed out that this instrument would form a convenient means of obtaining polarized light in cases where the length of a Nicol's prism is objectionable, for instance, under the stage of a Microscope; the light will be completely polarized if the plates be placed to receive the light at the polarizing angle, and the field will be much brighter than when a plate of tourmaline is employed.*

New Anthozoa.—Professor Studer, of Berne, continues in the July–August number of the 'Monatsbericht' of the Berlin Academy the description of the forms collected during the voyage of the 'Gazelle' round the world.

The new species (all of which are figured) are the following:—

<i>Madrepora patella.</i>	<i>Cereus brevicornis.</i>
„ <i>selago.</i>	<i>Calliactis marmorata.</i>
„ <i>candelabrum.</i>	<i>Eunodes Kerguelensis.</i>
„ <i>rubra.</i>	<i>Bolocera Kerguelensis.</i>
„ <i>nana.</i>	<i>Actinopsis rosea.</i>
<i>Seriatopora Jeschkei.</i>	<i>Paractis alba.</i>
„ <i>compressa.</i>	<i>Halcanpa purpurca.</i>
„ <i>contorta.</i>	<i>Edwardsia Kerguelensis.</i>
<i>Corynactis carnea.</i>	

* 'Nature,' vol. xix. p. 68.

Forty-six other species (not new) are also mentioned, and most of them described, four being figured (*Madrepora tubulosa*, Ehrbg.; *M. formosa*, Dana; *Seriatopora oculata*, Ehrbg.; *Epizoanthus cancriscius*, V. Mart.).

The last-mentioned form is parasitic on the outside of the shell of a whelk, the interior of which has again for a tenant a species of hermit crab. It is thus described:—Upon a flat basal membrane, which covers the shell of *Buccinum porcatum*, Gmel., inhabited by *Eupagurus*, rise the Polypes, which are 5–10 mm. high, and 4–7 mm. in diameter, at distances varying from 5–11 mm. They are principally on the dorsal side of the shell; the ventral side, which touches the ground by the motion of the *Pagurus*, having none. The whole of the basal membrane is penetrated with fine angular grains of sand, which consist for the greater part of quartz and a black hornblende. The spongy cœnenchyma completely absorbs the shell substance, and entirely takes its place. Even the spire consists of cœnenchyma impregnated with sand, excepting a small remainder, which is represented by a thin film of chalk. The tentacle disk of the naked polype is circular, the mouth small, and with two lips; on the circumference of the disk rise two circles of tentacles, the inner of which contains the largest tentacles. These are cylindrical, short, and not attaining the length of the circumference of the disk. Each circle contains twenty-four tentacles. The continuation of the body cavities of the polypes is formed by a fine network of canals which penetrate through the layer of cœnenchyma. From the bases of each polype further spread twenty-four canals as direct continuations of the chambers; after a short course, they lose themselves in a network of anastomosing canals, leaving only small spaces between, which are filled up with firm masses of cœnenchyma; they spread over the whole basal membrane. The colony when alive was rose red in colour. Six specimens of this beautiful form were taken in a drag net south of the Cape of Good Hope, in lat. 34° 13' 6" S., and long. 15° 0' 7" E., at 117 fathoms depth.*

Parthenogenesis in Bees.—According to a theory of M. Dzierzon developed by Professor Siebold, the eggs from which drone bees are produced, are deposited without fecundation by the queen, who can fecundate them or leave them unfertilized, according as they are intended to produce females or males. M. Pérez has recently discussed the subject in a note to the French Academy,† in which he says, “According to a classical theory, which had its birth in Germany and which no one now-a-days disputes, a fecundated egg of the queen bee is a female egg, and all unfecundated eggs of the queen bee are male. The mother bee, it is said, can even lay at will an egg of one or the other sex. This faculty, which is exceptional in the animal kingdom, is explained by assuming that the bee, at the moment of the passage of the egg into the oviduct, can apply to it or not a certain quantity of the seminal fluid contained in the seminal receptacle. Nevertheless, the organization of the generative apparatus of the bee

* ‘Monatsbericht d. Königl. Preuss. Akad.,’ 1878, July–Aug., p. 524.

† ‘Comptes Rendus,’ vol. lxxxvii. p. 408.

does not differ essentially from that of the majority of female insects, to which no one has ever thought of ascribing the power of acting at pleasure upon phenomena which seem to be absolutely removed from the influence of the will." The theory was founded, at least in part, upon the supposed fact that an Italian queen, fertilized by a German drone, would produce hybrid workers and queens (females) and drones exactly like herself. M. Pérez, however, disputes this on the ground of observations made upon a hive, the queen of which, the daughter of an Italian of pure race, had been fertilized by a French drone.

Some of the workers were Italian, others French, others mixed in various proportions of the two races. Among the males also were some as dark as those of the French race, although, according to the above theory, they ought all to have been of the Italian race, like their mother. He therefore examined 300 of the drones, and found 151 were pure Italian, 60 were hybrids of various degrees, and 83 were French.

Hence he regards it as evident that the drone eggs, like those of the females, are fertilized by contact with the fluid stored up in the seminal receptacle of the queen, and that Dzierzon's theory must fall to the ground.

On this paper M. A. Sanson in a later number* comments as follows:—

In a recent note M. J. Pérez is inclined to throw doubt on the phenomenon of parthenogenesis amongst bees, taking his stand on a certain interpretation of facts of heredity which he has observed. I have reason to be surprised at seeing him qualify as an hypothesis a fact, experimentally proved a great many times, and of which the direct verification is most easy. A proof of this fact was submitted to the Academy in 1868.† I presented a comb containing only cells of workers filled with males or drones developed in these cells. M. Bastian and I obtained it at Wissembourg, by making a queen bee lay in it, whose seminal receptacle was destitute of spermatozooids. I presented also, at the same time, some workers lodged in male cells, and hatched from eggs laid by a fecundated queen bee who had no other cells at her disposal. The object of our experiments was to examine into the theory advanced at that time by Landois relating to the mode of development of the sexes. All bee-keepers know that the old queens, who become drone-mothers, that is, who no longer lay any but male eggs, have exhausted their provision of spermatozooids. When their seminal receptacle is examined under the Microscope, it contains nothing but a perfectly transparent liquid. It is also known that the temperature of a young fecundated queen has only to be lowered to the degree which kills spermatozoa, to render her immediately a drone-mother. The young queens who have not paired, and the workers who sometimes lay in hives which have lost their queen by accident, and which are called "orphans," only lay male eggs.

These are the facts. It is easy to show, moreover, that the inter-

* 'Comptes Rendus,' vol. lxxxvii p. 659.

† Vol. lxxvii. p. 51.

pretation given by M. J. Pérez of his observations is not what it ought to be. In a hive of which the queen was, he says, the daughter of an Italian of pure race and had been fecundated by a French male, he examined with scrupulous care 300 males. He found Italian characters in 161; hybrid characters in varying degree in 66, and French characters in 83. From which it follows evidently, he adds, that the eggs of drones, like the eggs of females, receive the contact of the semen deposited by the male in the organs of the queen, and that the theory of Dzierzon, which was created to explain an ill-proved fact, becomes useless if this fact is disproved.

We are not at all struck by the evidence of such a conclusion, being in a position to interpose the known laws of heredity. With an Italian queen of incontestably pure race, the drones have exclusively Italian characters, although she may have paired with a male of another race. The workers alone are hybrids. The author has evidently had before him a case of reversion. In his hive there was, according to what he informs us, some true Italian workers, others which were French, others presenting a mixture, in different proportions, of the characters of the two races. This is conformable to the usual results of crossing. The queen of this hive was doubtless an Italian of the same kind as that of the workers of the first category. The atavism of a black male who had intervened in a preceding generation was manifested in different degrees. The same fact is often shown in the hives of Germany or of France in which Italian queens have been introduced. I remember having myself made a similar observation in that of M. Bastian, at Wissembourg, by proving the hybrid origin of the queen whose external characters were otherwise purely Italian.

In any case, the parthenogenesis of bees cannot be considered as an hypothesis admissible only by reason of its utility to explain a fact otherwise incontestable, since its reality was established by experiment long ago.

New Classification of the Vegetable Kingdom.—Professor Carnel, of Pisa, proposes the following classification:—(1) *Phanerogamia* (in the subdivisions discarding the distinction between Gymnospermia and Angiospermia, retaining as the two primary classes Monocotyledons and Dicotyledons, and giving the higher rank to the former). (2) *Schistogamia* (including *Characeæ* only). (3) *Prothallogamia* (vascular Cryptogams divided into *Heterosporæ* and *Isosporæ*). (4) *Bryogamia* (synonymous with *Muscineæ*, and divided into *Musci* and *Hepaticæ*). (5) *Gymnogamia* (Thallophyta or cellular Cryptogams). The simplest Gymnogamia possesses only a single form, which is reproduced organically by fission, by conidia and sporidia, or by gamogenesis, but without any sexual differentiation. In others there is sexual differentiation into male and female forms; a few have also a third neutral form, when the oospore produces zoospores instead of passing directly into the female form. They resemble the *Bryogamia* in the definite development of the neutral form and the indefinite development of the female form, but differ in the zoospore-like form of the phytozoa, and in the structure of the oogonium, which is iso-

lated and naked, and does not form parts of an archegonium. Professor Caruel altogether discards the old classification of Thallophytes into Algæ, Fungi, and Lichens, but does not propose any other in its place, and thinks it probable that as our knowledge of some of its forms increases, it will be broken up into several primary groups. He considers it would be an advantage if the term Cryptogamia were altogether discarded.*

The Morphology of the Oxytrichina.—Some important observations have been made by Professor V. Sterki on this subject,† which may be shortly summed up as follows:—

1. *Form and Size.*—The Oxytrichina and indeed the whole group of Hypotricha are usually described as having a convex dorsal and a flat ventral side. This is not universally true: *O. gibba* (*Amphisia gibba*, Sterki) has the ventral side concave with prominent edges, while other forms are equally convex on both surfaces; one is rounded and spindle-shaped, and another has a flat dorsal side. Distinct varieties of some species have been observed, as well as undoubted monstrosities.

2. *Body-substance—Consistency.*—Muscle-striæ (*Myophanstreifen*) occur in some cases. In *Stylonichia mytilus* suffering from want of water, all the protoplasm was seen to form a network enclosing communicating vacuoles in which was contained a watery fluid or “serum.” Probably the contractile vesicle is a modified vacuole. There is an unbroken chain of transition forms between species with a carapace and those possessing the greatest amount of “*Metabolicität*” or power of changing their form.

3. *Peristome.*—The structure in the œsophagus of *Stylonichia*, described as the mouth-cleft by Stein, and as a second undulating membrane by Engelmann, is really a row of long, delicate, undulating cilia; the author calls these the *endoral* row. He also describes a row of *paroral* cilia, inserted along the line of attachment of the adoral row, and directed inwards.

4. *Ciliation.*—Those cilia which are disposed in rows are usually fewer in number and of greater size than they are usually represented. Thus Sterki counts forty to fifty large cilia in the adoral row of *Stylonichia mytilus*, as against the 200 fine ones of Stein. There is no absolute distinction in nature between styles and bristle-like cilia; moreover, in one and the same species intermediate forms are met with between the finest cilia and the strongest “styles.” The marginal and anal cilia are of a flattened form; the large frontal and ventral cilia of *Stylonichia* and *Oxytricha* are often polygonal in section; in *S. mytilus* some of the frontal cilia are semicircular in section. The flattening of cilia is most marked in the adoral set, which are so modified as to form fan-like plates, called by the author *membranellen* (*Membranellen*); he finds them in all *Oxytrichæ* as well as in *Euplote* and *Amphidiscæ*, in the peritrichous *Halteria* and in *Stentor*. When in action, the opposite edges of the row of *membranellen* give the appearance of a double row of cilia. In the matter of the location of

* Mr. A. W. Bennett, in ‘*American Naturalist*,’ vol. xii. p. 747.

† ‘*Zeitsch. f. wiss. Zool.*,’ vol. xxx.

cilia there are two distinct groups of *Oxytrichina*, or rather two extreme modifications with intermediate forms. In one of these, including *Oxytricha*, *Stylonichia*, &c., the cilia are greatly differentiated both as to form and function, and limited in number: in the other (*Uroleptus*, *Urostyla*) there are two rows and upwards on ventral cilia, each row containing an indefinite number. A new genus and species, *Trichogaster pilosus*, is interesting from the fact that it is the lowest known form of *Oxytrichina*, its cilia presenting the smallest amount of differentiation.

For the sake of clearness, the author proposes to distinguish by numbers the eight characteristic frontal cilia of *Stylonichia*, *Oxytricha*, *Histrio* (nov. gen.), *Pleurotricha*, and *Allotricha* (nov. gen.). The dorsal cilia are not, as Stein thought, young marginal cilia. They occur over the whole dorsal surface in longitudinal rows, each row being set in a distinct furrow. They exhibit little movement, and are differently constructed to the other cilia, being mere cuticular processes, containing but little protoplasm. They may be absent.

5. *Transverse Division*.—A very exact account is given of the development of the new cilia of the two daughter-individuals arising by a process of transverse division. According to Stein, the new marginal cilia arise as a single longitudinal row on each side, which subsequently divides: but according to Sterki this account is incorrect. He states, in fact, that the mode of origin of the marginal cilia is different on the right and left sides, and takes place as follows:—On the right side the row of marginal cilia of the parent splits up into three groups, enclosing two intervals, in each of which appear fine close-set cilia. These arise somewhat nearer the margin than the old cilia, and, as development goes on, they get further and further from one another, the rows themselves, at the same time, approaching. The old cilia simultaneously undergo absorption, although young individuals are often met with which have some of the maternal cilia left. On the left side the parental marginal cilia split up into only two groups: in the single interval between them appears one of the new rows, the second making its appearance between the anterior end of the old row and the adoral cilia. A further difference between the two sides is met with in the fact that the new marginal cilia of the left side arise further from the margin than the old ones.

In *Stylonichia*, *Oxytricha*, and *Histrio*, the frontal, ventral, and anal cilia of each daughter-cell arise from a common group of eighteen cilia, that of the anterior individual being situated to the right of the parent peristome, that of the posterior individual to the right of the new peristome. Each group consists of six oblique rows, containing 1, 3, 3, 3, 4, 4, cilia respectively, counting from left to right. Of these the single cilium of the first (leftmost) row, the two anterior cilia of the second and third rows, and the three anterior of the sixth, become the eight frontal cilia; the two anterior cilia of the fourth, and the three anterior of the fifth row, become the five ventral cilia; while the posterior cilium of each row except the first becomes one of the five anal cilia.

During division, the anterior or old peristome alters its form,

becoming slender and flattened like the new or posterior peristome. Afterwards, both peristomes increase in length and breadth, so that at the end of the process they are both in the same stage. The new caudal cilia always arise, as Stein made out in *Styloniichia*, on the dorsal side: the præoral cilia and undulating membrane are formed anew, the old ones being absorbed. The adoral cilia or membranelles are probably directly transformed, like the peristome, into those of the new individual. The new cilia all exhibit a sort of clumsiness of movement, quite different to the facility of their adult motions.

The author remarks that the process of division in *Oxytrichina* is not one of true fission, but is rather one of bud-formation.

In an appendix Sterki gives the characters of some new genera and species he has established. The new genera are *Histrio* (= *Styloniichia histrio*), *Amphisia*, and *Gonostomum* (separated from *Oxytricha*), *Stylo-nethes*, *Allotricha*, *Strongylidium*, and *Trichogaster*.

The Sexual Process in Diatoms.—An article on this question, containing a discussion on the sexual process in general, occurs in 'Der Naturforscher' for November 23, 1878. The writer begins by a statement of the five methods in which the auxospores of Diatomaceæ are known to be formed: these are the following:—

1. A single individual throws off both valves, secretes a mucilaginous investment, extends itself, and grows. The auxospore thus formed surrounds itself with a thin membrane devoid of silica, and within this secretes the usual pair of siliceous valves, thus forming the "firstling-cell" (Erstlingzelle) of a new generation.

2. The protoplasm of a cell divides into two naked daughter-cells, which make their way out of the mother-cell, and form an auxospore.

3. Two individuals, lying close to one another, secrete an investment of mucilage: both these throw off their valves, and so form a pair of naked cells lying in close proximity to one another, but without actually touching. Both of these extend parallel to one another in the direction of their length until they attain the normal size of auxospores; outside these a thin membrane (perizonium) is found, and within this the ordinary siliceous valves.

4. Two individuals, generally surrounded by a gelatinous investment, throw off their old valves, and coalesce into a single naked mass of protoplasm, which grows into a single auxospore.

5. Two individuals, again surrounded by mucilage, throw off their old valves, and each divides transversely into two naked daughter-cells, each of which then coalesces with the corresponding daughter-cell of the other individual. Two naked zygospores are thus formed, each of which becomes an auxospore, and subsequently, by the formation of siliceous valves, a firstling-cell.

Of these five methods the fourth and fifth are certainly sexual, being a process of zygospore-formation. The first mode is as certainly asexual, a process of cell-formation by rejuvenescence, so that in the single group of *Diatomaceæ* the auxospores, by which a new generation is started, may be produced either sexually or asexually.

The second mode requires further investigation: about the third there is a difficulty; it is a process of rejuvenescence, taking place,

however, only when two individuals are present; so that a mutual action, independent of actual contact, is evidently exerted. This process the writer compares to the mode of fertilization in *Florideæ*, where cells far removed from the trichogyne, to which alone the fertilizing influence of the spermatia is applied, are stimulated to a new and vigorous growth by the impregnation; and to the process which obtains in *Phanerozygams*, where the protoplasts of the male and female cells are separated from one another by the cell-wall of the pollen tube. In both these cases, however, one of the sexual cells only (the female cell) undergoes further growth, the other or male cell disappearing; while in the desmids in question, the action of the two cells is mutual.

The writer then defines sexuality as the action of two or more cells on one another, by means of which a new process of growth, in one or all of these cells, is set up, and the sexual action consists in the stimulation of the sexual cells to a new and peculiar growth, such growth being impossible without that stimulation.

Microscopical Injection of Molluscs.—Dr. W. Flemming has originated * a method of killing molluscs for purposes of fine injection, which he has found very successful. He recommends freezing the animal by means of a mixture of ice and salt, and placing it, when frozen, in tepid water for a quarter of an hour; it is then found to be dead and stiff with the valves gaping, and the muscles no longer offer any opposition to the passage of the injection. Unlike many other methods of killing, this freezing process produces no injury to the tissues.

In injecting *Lamellibranchs* from the heart, there is great danger of extravasation. To obviate this difficulty, Flemming recommends wiping the surface carefully after insertion of the cannula, and then covering the animal with a soft paste of plaster of Paris. If this is done successfully, the cannula is firmly fixed in its place, and extravasation from the cut surfaces of the adductors and other dangerous places is effectually prevented.

Parasitism amongst Infusoria.—Dr. J. van Rees† has observed three cases of parasitism in this group, two of which are new, while in the case of the third his account differs somewhat from that of its discoverer.

1. *Vorticella microstoma*.—The curious parasite *Endosphæra* having this species for its host, was first described by Engelmann in the first volume of the ‘*Morphologisches Jahrbuch*.’ *Endosphæra* is a peritrichous infusor found in the interior of the body of *Vorticella*, where it multiplies by budding, the buds making their way out of the body of their host and swimming freely in the water for a longer or shorter time, until another *Vorticella* is met with. Engelmann stated that the parasite is then taken into the body of its host by the ciliary current of the latter, but, according to Rees, it fixes itself about half-way between the proximal and distal ends of the *Vorticella*’s body, into which it gradually penetrates, still showing its nucleus and con-

* ‘*Archiv f. Mik. Anat.*,’ vol. xv. p. 252.

† ‘*Zeitsch. f. wiss. Zool.*,’ vol. xxxi. p. 473.

tractile vesicle. Engelmann found that a posterior circle of cilia was developed in the infected *Vorticella*, which then swam away, but in the cases observed by Rees, the *Vorticella* drew itself together and sometimes became encysted. In one case quite an *Endosphæra* epidemic was observed.

2. *Vorticella campanula*.—Amongst normal individuals some specimens were seen containing large, strongly refracting spheres, exhibiting a single contour, granular contents, and a dark, strongly refracting, spherical or oval nucleus; no contractile vesicle was observed. Each *Vorticella* contained from two to eight of the spheres, the size of which was inversely proportional to their number, but usually constant for each infected specimen. In one case, however, one sphere was decidedly larger than any of the other in the same specimen, and had two nuclei, whence it is inferred that multiplication takes place by division within the body of the host. The further fate both of host and parasite is unknown, and no opinion is advanced as to the nature of the latter.

3. *Oxytricha fallax*.—The appearance presented by the infected individuals in this case, seemed, at first sight, to lend great support to the theory that the nucleus is a germ-producing organ. The parasite, to which, as in the preceding case, the author gives no name, occurs within the nucleus of *Oxytricha*, in the form, at first, of minute spheres, which are, except in the case of the smallest of all, nucleated, but are devoid of a contractile vesicle. In further stages the spheres increased greatly in size, and exhibited a distinct cell-wall, and underwent multiplication by fission. In the latter process the cell-wall took no part, and the division masses did not at first round themselves off. The nucleus of the *Oxytricha* became, of course, greatly altered in shape, and in the final stages usually disappeared. The spheres either escaped through an aperture in the substance of their host, or were liberated by its disintegration. In either case, the daughter-cells of spheres which had undergone division, rounded themselves off, after being liberated, and exhibited slow movements, due, the author thinks, to very minute cilia, which he believes he was able to see in some instances. After a time the movements ceased, and the daughter-cells were gradually transformed into a granular mass, devoid of any trace of cell-contours. The author seems to think it probable that the cell-colonies thus formed divide into single cells, and that these latter, or the products of their division, finally penetrate into the body of *Oxytricha fallax*. He believes the parasite to be one of the lower *Algae*.

Microscopy at the American Association for the Advancement of Science.—At the meeting of this Association, to be held in August, 1879, Professor E. W. Morley, of Hudson, Ohio, will be the Chairman of the sub-section of Microscopy.

Germination of the Spores of *Volvox dioicus*.—Although the 'Journal de Micrographie' says that 'All microscopists are acquainted with the work of Cohn on *Volvox globator*;' * we believe we are correct in saying that very little was known of it in this country until the

* 'Beiträge zur Biologie der Pflanzen,' vol. i. part 3, 1875.

publication of Mr. A. W. Bennett's valuable summary of Cohn's views last year.* M. F. Henneguy, of the College of France, two years ago communicated to the Academy of Sciences a note as to the reproduction of *Volvox dioicus* (Cohn), in which he pointed out the gradual appearance of sexuality in these organisms, the male sex appearing before the female in proportion as the species degenerates by sexual reproduction. He has now added further observations, of which the following are the more important results.†

The spores arising from the fecundation of the oospheres by the antherozoids fall to the bottom of the water and remain in a stationary state for a long time. Cohn thought that these spores must be dried before germinating, though he did not observe the germination. Cienkowski saw the contents of the spore divide, and he thought that each sphere of segmentation became ultimately a cœnobium.

M. Henneguy has ascertained that, contrary to Cohn's opinion, the spores of *Volvox* pass the winter in the water. Those observed were collected in the mud of a basin of the Jardin des Plantes, deep and constantly filled with water.

These spores, of an orange-yellow, possess two enveloping membranes—an exospore with double outline, and a very thin endospore. At the moment of germination, the exospore is torn open, and the swollen endospore is seen to project through the openings. At the same time the contents of the spore, separated from the endospore by a clear space, divide into two equal parts, which, by successive bipartitions, give birth to four, eight, sixteen, &c., small cells. The cells, at first orange-yellow, acquire a brown tint, becoming more and more greenish in proportion as the work of division advances. When the segmentation of the spore has terminated, the cells form a spherical layer analogous to the blastoderm of a holoblastic ovum. Each element then acquires two vibratile cilia. The endospore disappears and the young *Volvox*, thus constituted, moves freely in the water. The cells, at first very close together, separate one from another by the interposition of a gelatinous matter.

A fact interesting to note is the presence among the vegetative cells of the *Volvox* still contained in the endospore, of elements larger than the others, which will subsequently give origin to the daughter colonies by a mode of division analogous to that observed in the spore.

The spores of *Volvox* therefore germinate in water, and each of them produces a single colony by a process of segmentation identical with that which gives rise to a daughter colony at the expense of a cell of the mother colony.

Parasitism of a Coral on a Sponge.—The discussion at the January meeting on this subject will be found in the 'Proceedings' at p. 110.

* See 'Pop. Sc. Review,' N. S., vol. ii. p. 225.

† 'Journal de Micrographie,' vol. ii. p. 485. 'Bull. Soc. Philomath.,' Paris, July, 1878.

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QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE, N. S., Vol. XIX. (January):—

Memoirs.—On the Existence of a Head-Kidney in the Embryo Chick, and on certain points in the Development of the Müllerian Duct. By F. M. Balfour, M.A., Fell. Trin. Coll. Camb.; and Adam Sedgwick, B.A., Schol. Trin. Coll. Camb. (2 plates.)

Notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition. By Henry B. Brady, F.R.S. (3 plates.)

Researches on the Flagellate Infusoria and Allied Organisms. By O. Bütschli, Prof. of Zoology in the Univ. of Heidelberg. (1 plate.) (Abridged from 'Zeitsch. f. wiss. Zool.' vol. xxx.)

On the Morphology and Systematic Position of the Spongida. By F. M. Balfour, M.A., Fell. Trin. Coll. Camb. (3 woodcuts.)

Flagellated Organisms in the Blood of Healthy Rats. By Timothy Richards Lewis, M.B. (1 woodcut.)

Notes and Memoranda.—Observations on the Capitellidæ by Dr. Hugo Eisig. By F. M. Balfour.—Bacteria as the cause of the Ropy Change of Beetroot Sugar. By Prof. Lankester.—Stein's 'Organismus der Infusionsthier.'.

Proceedings of Societies.—Dublin Microscopical Club, April 11th, May 16th, June 19th, July 20th.

* The contents of Microscopical Journals are given in full; in other cases such of the contents as relate to Biological subjects (principally Invertebrata and Cryptogamia), or are otherwise interesting to Microscopists.

ANNALS AND MAGAZINE OF NATURAL HISTORY, Fifth Series, Vol. III., No. 13 (January):—

Supplementary Observations on the Anatomy of *Spirula australis*, Lamarck. By Prof. R. Owen, C.B., F.R.S., &c. (3 plates.)

On *Plectronella papillosa*; a new genus and species of Echinonematous Sponge. By W. J. Sollas, M.A., F.G.S., &c. (4 plates.)

On the Bryozoa (Polyzoa) of the Bay of Naples. By Arthur Wm. Waters, F.L.S., F.G.S. (4 plates.)

Miscellaneous.—Germination of the Spores of *Volvox dioicus*. By M. Henneguy. (From 'Bull. Soc. Philomath.' Paris.)—On the Anatomy of the Larva of *Eristalis tenax*. By Dr. Batelli. (From 'Soc. Tosc. di Scienze Nat., Proc. Verb.')

HARDWICKE'S SCIENCE-GOSSIP, No. 169 (January):—

On Mounting Micro-Fungi. By Charles F. W. T. Williams. (1 woodcut.)

On the Development of the House-fly and its Parasite. By M. H. Robson. (4 woodcuts.)

Microscopy.—"The Germ Theory of Infectious Diseases" (Dr. Drysdale's Address).—A New Lamp for Microscopic Mounting (Geo. Clinch).—Section Cutting (Dr. Marsh's book).—The Quekett Microscopical Club (No. 38 of the Journal).—Microscopy in Natal (S. C. Adams).—Sections of Quartz (R. S. P.).—Diatoms in Coal (E. T. Scott).

MIDLAND NATURALIST, Vol. I., Nos. 1-12 (January to December, 1878):—

Fresh-water Life. I. Entomostraca. II. Rotifera. III. Infusoria. By E. Smith, M.A.

The Chlorophyll-body and its relation to Starch. By Prof. W. Hinds, M.D.

Parasites of Man. By T. Spencer Cobbold, M.D., F.R.S.

Fresh-water Algæ. By A. W. Wills, F.C.S. (With 3 plates.)

Raphides and Plant Crystals. By Mrs. G. R. Cowen.

Economic Mycology. By J. Griffith Morris.

Notes on *Melicerta ringens*. By F. A. Bedwell, M.A., F.R.M.S.

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How we found the Microzoa in the Boulder Clays of Cheshire, &c., and what were the results. By W. Shone, F.G.S.

Note on *Æcistes pilula*. By A. W. Wills.

Note on a Thecated Rotifer from Sutton Park. (With a plate.) By A. W. Wills.

On the Microscopical Examination of Clay. By the Rev. H. W. Crosskey, F.G.S.

A Productive Pond.—Pond Life.—Postal Microscopical Society.—A Microscopic Trap for a Rover.—Dudgeon's Tube for examining small Organisms in Water.—Dipping Tube.—Pond Life.—Collectors' "Condensing" Bottle.—*Conochilus volvox*.—Mounting.—Mr. Bolton's Microscopists' and Naturalists' Studio.—Simple Compressorium.—Ross's Four-tenths' Condenser, used for Dark-field Illumination of Rotifers and Infusoria.—Revolving Microscopic Table.

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Parasites of Man. By T. Spencer Cobbold, M.D., F.R.S., &c.

The Bladderworts and their Bladders. By W. Southall, F.L.S.

Microscopy.—The Oil-Immersion $\frac{1}{8}$ inch. (F. A. Bedwell) Drawing Objects under the Microscope.—Microscopic Objectives.

NATURE, Vol. XIX:—

December 5 and 12:—Hæckel on the Liberty of Science and of Teaching.—December 19:—Review of No. 1 of the 'American Quarterly Microscopical Journal.'

Biological Notes.—Sensitive Organs in Asclepiadaceæ.—Structure and Affinities of Characeæ.

POPULAR SCIENCE REVIEW, N. S., Vol. III., No. 9 (January):—

The Self-Fertilisation of Plants. By the Rev. George Henslow, B.A., F.L.S., F.G.S. (1 plate.)

JOURNAL OF THE LINNEAN SOCIETY (BOTANY), Vol. XVII., No. 100 (issued 31st December):—

Observations on *Hemileia vastatrix*, the so-called Coffee-Leaf Disease. By the Rev. R. Abbey, M.A., F.G.S., Fell. Wadham Coll. Oxford. (2 plates.)

TRANSACTIONS OF THE LINNEAN SOCIETY, Second Series, Botany, Vol. I., Part 5:—

New British Lichens. By the Rev. W. A. Leighton, B.A. Camb., F.L.S., F.B.S. Ed., &c. (1 plate.)

New Irish Lichens. By the same Author. (1 plate.)

Contributions to the Lichenographia of New Zealand. By Charles Knight, F.L.S., Auditor-General of New Zealand. (2 plates.)

Second Series, Zoology, Vol. I., Part 7:—

On the Male Genital Armature in the European *Rhopalocera*. By F. Buchanan White, M.D., F.L.S., &c. (3 plates.)

PROCEEDINGS OF THE ROYAL SOCIETY, Vol. XXVIII., No. 190:—

Address of the President, Sir Joseph Hooker, C.B., K.C.S.I.

PROCEEDINGS OF THE SCIENTIFIC MEETINGS OF THE ZOOLOGICAL SOCIETY OF LONDON,* 1878, Part 2 (issued 1st August, 1878):—

Remarks upon the Stridulating Organ of the Common Rock-Lobster. By T. J. Parker.

Part 3 (issued 1st October, 1878):—

Note on the Stridulating Organ of *Palinurus vulgaris*. By T. Jeffery Parker, Assoc. R.S.M. (1 plate.)

United States.

AMERICAN JOURNAL OF SCIENCE AND ARTS, Third Series, Vol. XVI., No. 95 (November):—

Notice of Recent Additions to the Marine Fauna of the Eastern Coast of North America, No. 2. By A. E. Verrill.—[Echinodermata, 7 (4 sp. nov.); Hydrozoa, 2 (1 sp. nov.); Anthozoa, 7 (3 sp. nov.); Mollusca, 3 (1 sp. nov.).]

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AMERICAN NATURALIST, Vol. XII., No. 11 (November):—

Plaster of Paris as an Injecting Mass. By Simon H. Gage, B.S. (3 woodcuts.)

General Notes.—Botany:—New Classification of the Vegetable Kingdom (Prof. Caruel's). By A. W. Bennett. Zoology:—The Cocoons of *Microgaster*. By W. A. Buckout.

Microscopy.—National Microscopical Congress (*continued*).—Exchanges.

Proceedings of Scientific Societies.—San Francisco Microscopical Society, July 11.

* These will be hereafter referred to as 'Proceedings of the Zoological Society.'

No. 12 (December):—

General Notes.—Botany:—*Volvox globator*. By A. W. Bennett.

Microscopy.—National Microscopical Congress (*continued*).

France.

JOURNAL DE MICROGRAPHIE, Vol. II., No. 12 (December):—

Revue—M. F. Henneguy on "The Germination of the Spores of *Volvox dioicus*."—The Quarterly Journal of Microscopical Science, and other English and American Journals.

The Lymphatic Hearts (*conclusion*). By Prof. Ranvier.

Preliminary Note on the intimate Structure of the Tongue of Parrots. By Prof. G. V. Ciaccio.

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On Foreign Microscopes (*continued*). By Dr. J. Pelletan. (1 plate.)

Organisation and Nature of *Hygrocrocis arsenicus* developed in the Arsenical Solution known as Fowler's Liquid. (From 'Comptes Rendus.')

Process for making Systematic Dry Preparations of Diatoms. By G. Marmod.

Diatoms of the Archipelago of the West Indies. (From the Bulletin of the Swedish Academy.) (9 woodcuts.)

The Thallus of Diatoms. By Dr. Matteo Lanzi. (From the 'Annales de la Société Belge de Microscopie.')

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Microscopical Techniques: On the Gold Method. By Dr. A. W. L. Hénocque.

ARCHIVES DE ZOOLOGIE EXPÉRIMENTALE AND GÉNÉRALE (Lacaze-Duthiers), Vol. VII., No. 1:—

On the Genus *Sagitella* (N. Wagn.). By M. Uljanin. (4 plates.)

Comparative Anatomy of the Skeleton of the Stelleridæ. By Dr. C. Vignier. (13 woodcuts and 4 plates.)

COMPTES RENDUS Hebdomadaires des Séances de l'Académie des Sciences,* Vol. LXXXVII., No. 17 (21st October):—

On the Nerve Terminations in the Striated Muscles. By M. S. Tschiriew.

On the Hydrophorous Reservoirs of *Dipsacus*. By M. A. Barthélemy.

The Influence of Salicylic and Thymic Acid and some Essences on Germination. By M. Ed. Haeckel.

No. 18 (28th October):—

On Parthenogenesis in Bees. By M. A. Sanson.

No. 19 (4th November):—

On the Region of the Solar Spectrum indispensable to Vegetable Life. By M. P. Bert.

On Relations presented by Phenomena of Motion proper to the Reproductive Organs of some Phanerogams with Cross and Direct Fecundation. By M. Ed. Haeckel.

No. 20 (11th November):—

The Measurement of the Magnifying Power in Optical Instruments. By M. G. Govi.

On some Causes of Inversion of Cane Sugar, and on the consecutive alterations of the Glucoses formed. By M. Durin.

* These will be hereafter referred to as 'Comptes Rendus—French Academy.'

On the Oviposition of Bees. By M. M. Girard.

The presence of Alcoholic Ferment in Air. By M. P. Miguel.

Organization of *Hygrocrocis arsenicus*, Bréb. By M. L. Marchand.

No. 21 (18th November):—

Migration of Pucerons of Galls of *Lentiscus* to the Roots of Gramineæ. By M. J. Lichtenstein.

Disease of Lettuce (*Peronospora gangliiformis*, Berk.). By M. Max Cornu.

No. 22 (25th November):—

Critical Examination of a posthumous MS. of Claude Bernard on Alcoholic Fermentation. By M. L. Pasteur.

No. 24 (9th December):—

Diseases of Plants caused by *Peronospora*: attempted treatment. Application to the Lettuce Disease (*P. gangliiformis*, Berk.). By M. Max Cornu.

On a Disease of the Coffee Tree observed in Brazil. By M. C. Jobert.

On the Diffusion of Heat by Leaves. By M. Maquenne.

No. 25 (16th December):—

Observations on the Note of M. Pasteur relative to Alcoholic Fermentation. By M. Berthelot.

On Hæmocyamine, a new Substance from the Blood of the Poulp (*Octopus vulgaris*). By M. L. Fredericq.

On the Influence of the different Colours of the Spectrum on the Development of Animals. By M. E. Yung.

No. 26 (23rd December):—

Formation of Leaves and order of appearance of their first vessels in the Gramineæ. By M. A. Trécul.

On the Chromatic Function in the Poulp. By M. L. Fredericq.

On the Excretory Apparatus of *Solenophorus megaloccephalus*. By M. J. Poirier.

New Investigations on the suspension of the Phenomena of Life in the Embryo of the Hen. By M. Dareste.

No. 27 (30th December):—

Reply to M. Berthelot. By M. Pasteur.

Observations of M. Trécul on M. Pasteur's communication, and reply of M. Pasteur.

Poison of Serpents. By M. Lacerda.

On the Function of Chlorophyll in green Planariæ. By M. P. Geddes.

Observations of M. de Quatrefages relative to the preceding communication.

Belgium.

BULLETIN DE LA SOCIÉTÉ BELGE DE MICROSCOPIE, Vol. V., No. 2:—

Proceedings of the Meeting of 28th November, containing:—

Remarks of M. Renard on the Results of the Microscopic Study of Thin Plates of Fulgarite, and of some Products of Fusion of Quartzose Substances.

Remarks of M. Ledeganck and M. Coppez on Follicular Conjunctiva. (1 plate.)

Notes on some Diatoms. By F. Kitton, F.R.M.S., Corresponding Member of the Society. Translated by M. J. Deby. (2 woodcuts.)

Analytical and Critical Review of various articles on Fungi and other Cryptogamia, by M. Max Cornu; of the 'Revue des Sciences Naturelles de Montpellier'; of an article by M. E. Mallard on Bravaisite, a new mineral substance, in the 'Bulletin de la Société Mineralogique de France,' 1878, No. 1; and of an article by M. J. Thoulet in No. 2 of the same 'Bulletin,' on the Variations of the Angles, and Planes of Cleavage on the Faces of the principal Zones in Pyroxene, Amphibole, Orthose, and Triclinic Felspars.

Germany.

ARCHIV FÜR MIKROSKOPISCHE ANATOMIE, Vol. XV., Part 4 (issued 30th October, 1878):—

On the Mid-Gut of *Cobitis fossilis*, Lin. By Dr. H. Lorent. (1 plate.)

Contributions to the Comparative Morphology of the Skeletal System of Vertebrata. By Dr. A. Goette, Professor at Strassburg. II. The Vertebral Column and its Appendages. (6 plates.)

Contributions to the Anatomy of the Eye. By Dr. Ludwig Loewe, of Berlin; with the co-operation of Dr. N. v. Kries. (3 plates.)

The Histogenesis of the Retina, together with Comparative Observations on the Histogenesis of the Central Nervous System. By Dr. Ludwig Loewe. (1 plate.)

Preliminary results of a larger work on the Comparative Embryology of Insects. By Dr. V. Graber, Professor of Zoology at the Czernowitz University. (1 woodcut.)

Vol. XVI., Part 1 (issued 20th November, 1878):—

Further communication on the Cell-spaces of Hyaline Cartilage. By Dr. Albrecht Budge. (1 plate.)

On the so-called Hydatids of Morgagni. By Dr. Ludwig Löwe, of Berlin.

The Elastic Fibres of the Ligamentum nuchæ, under the action of Pepsin and of Trypsin. By Dr. Ph. Pfeaffer. (1 plate.)

On New Sense-organs in Insects, resembling Otocysts. By Dr. V. Graber. (2 plates.)

The Fibrillar Structure of the Nervous Elements of Invertebrata. By Dr. Hans Schultze, of Kiel. (2 plates.)

On the Changes of the Serous Epithelium in the exposed Mesentery of the Frog. By Dr. Richard Altmann, of Giessen. (3 woodcuts.)

Contributions to the Comparative Morphology of the Skeletal System of Vertebrates. By Dr. A. Goette, Professor at Strassburg. II. The Vertebral Column and its Appendages. (3 plates.)

Part 2 (issued 20th December):—

Studies on the Protozoa of Northern Russia. By C. von Mereschkowsky, of St. Petersburg. (2 plates.)

The Division of Cartilage Cells: a contribution to the Theory of Cell-division. By W. Schleicher. (From the Histological Laboratory at Ghent.) (3 plates and 3 woodcuts.)

The Employment of Mixtures of Chromic and Osmic Acids in Investigations on the Auditory Organs of smaller Animals. By Dr. Max Flesch, Professor at Würzburg.

Contributions to the knowledge of the Cell and of its Vital Phenomena. By Walther Flemming, Professor at Kiel. (4 plates.)

ZEITSCHRIFT FÜR MIKROSKOPIE, Vol. I., Part 10 (November):—

The making of Durable Microscopic Preparations (*conclusion*). By A. Münster.

Reports on sixteen articles from various periodicals relating to Animal Histology.

Minor Communications.—Micro-photography.—Two new Journals ('Brébissonia' and 'American Quarterly Microscopical Journal').—New Improvement in the Object-holder for Electrifying Microscopic Objects.—Orchella as a Staining Material.

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JAHRBÜCHER FÜR WISSENSCHAFTLICHE BOTANIK, Vol. XI., Part 4:

On *Monostroma bullosum*, Thur., and *Tetraspora lubrica*, Ktz. By J. Reinke. (1 plate.)

The Development of the Embryo of Horse-tails. By R. Sadebeck. (3 plates.)

Contributions to the Germination of the Schizæacæ. By H. Bauke. (4 plates.)

JENAIISCHE ZEITSCHRIFT FÜR NATURWISSENSCHAFT, N. S., Vol. V.,
Part 4:—

Action of Light and Heat on Swarm-spores. By Dr. E. Strasburger.
On Polyembryony. By Dr. E. Strasburger. (5 plates).

MORPHOLOGISCHES JAHRBUCH, Vol. IV. (Parts 1-3 and Supp.):—

- Anatomy of *Isis Neapolitana*, nov. sp. By G. v. Koch. (1 plate.)
Observations on the Synonymy of *Isis elongata*, Esper, with *Isis Neapolitana*.
By G. v. Koch.
Contributions to the Anatomy of *Chiton*. By Dr. H. v. Ihering. (1 plate.)
Observations on Neomenia and on the Amphineura in general. By Dr. H. v. Ihering.
Contributions to the knowledge of the Formation, Fecundation, and Division of the Animal Ovum. Part III. By Dr. O. Hertwig. (6 plates.)
Communications on *Gorgonia verrucosa*, Pall. By G. v. Koch. (1 plate.)
On the Degeneration of the Visual Organs in Arachnida. By Ant. Stecker. (1 plate.)
On *Gloidium quadrifidum*; a new Genus of Protista. By Prof. N. Sorokin. (1 plate.)
The Skeleton of the Alcyonaria. By G. v. Koch. (2 plates.)
Communications on the Coelenterata. On the Phylogeny of the *Antipathidæ*.
By G. v. Koch. (1 plate.)
On the Origin and Development of the Elastic Tissue. By Dr. L. Gerlach. (2 plates.)
Minor Communications, &c.—Are the Segmental Organs of the Annelida homologous to those of the Vertebrata? A Reply to Dr. Fürbringer. By C. Semper.—
Muscle-epithelium in Anthozoa. By Dr. O. Kling. (Preliminary communication.)—Review of H. Grenacher's Researches on the Anthropod Eye.

ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE, Vol. XXXII.,
Part 1 (issued 19th December, 1878):—

- On the Sexual Organs of the Cephalopoda. First contribution. (4 plates.)
By J. Brock.
Researches on the Structure and Development of Sponges. Sixth communication: The Genus *Spongelia*. (4 plates.) By F. E. Schulze.
Studies on the Anatomy of Respiratory Organs. 1. The Anatomy of the Gill of *Serpula*. By L. Löwe. (1 plate.)

MONATSBERICHT DER KÖNIGLICHEN PREUSSISCHEN AKADEMIE DER
WISSENSCHAFTEN ZU BERLIN* (1878, February):—

On the Reflexion of Light by the Surfaces of small Crystals. By Herr Websky. (Concluded, with a plate, in the July-August number.)

March:—

The Nerve-system of the Chaetognatha. By Prof. Langerhans.

April:—

On the Specific Heat of Animal Tissue. By Prof. Rosenthal.
Summary of Arachnida collected in Mozambique. By Dr. F. Karsch. (2 plates, containing microscopic details.)

May:—

Investigations of Absorptive-spectra (of Inorganic and Organic Bodies). By Herr H. W. Vogel. (2 plates.)

* These will be referred to hereafter as 'Monatsbericht—Berlin Academy.'

June :—

Congratulatory Address of the Academy to Professor Schwann on his Jubilee.

July—August :—

Second communication on the *Anthozoa polyactinia* collected during the voyage of the 'Gazelle' round the World. By Prof. Dr. Th. Studer. (5 plates.)

Austria.

SITZUNGSBERICHTE DER KAISERLICHEN AKADEMIE DER WISSENSCHAFTEN.* Section I. Mathematics—Natural Science. Vol. LXXVII. Parts 1 and 2 (January and February) :—

The Undulating Nutation of Internodes. A contribution to the Theory of the Longitudinal Growth of Plant-stems. By Julius Wiesner.

Note on the Relation of Phloroglucine and some allied Bodies to the Lignified Cell Membrane. By Julius Wiesner.

On the Degeneration of the Leaf-growth of some Amygdaleæ produced by Species of *Eroscus*. By Emerich Ráthay. (1 plate.)

Contributions to the fuller knowledge of the *Tunicata*. By Prof. C. Heller. (6 plates).

Parts 3 and 4 (March and April) :—

On the Embryology of Ferns. By H. Leitgeb. (1 plate.)

On Peculiar Openings in the upper Epidermis of the Floral Leaves of *Franciscea macrantha*, Pohl. By M. Waldner. (1 plate.)

On the Origin of the Holes on the Leaf of *Philodendron pertusum*, Schott. By Frank Schwarz. (1 plate.)

Part 5 (May) :—

The Nostoc Colonies in the Thallus of Anthocerotæ. By H. Leitgeb. (1 plate.)

Researches on the Organisation of the Brain of Invertebrate Animals. Parts I. and II. (Cephalopoda, Tethys, Crustacea). By M. J. Dietl. (10 plates.)

Contributions to the Embryology of the Chætopoda. By Michael Stossich. (2 plates.)

Comparative Anatomy of the Seeds of *Vicia* and *Ervum*. By Dr. Günther Beck. (2 plates.)

Russia.

BULLETIN DE L'ACADEMIE IMPÉRIALE DES SCIENCES DE ST. PETERSBOURG, † Vol. XXIV., No. 4.

The Development of Cephalodia on the Thallus of the Lichen *Peltigera aphthosa*, Hoffm. By M. Babikoff. (1 plate.)

* These will be hereafter referred to as 'Sitzungsberichte—Vienna Academy.'

† These will be referred to hereafter as 'Bulletin—St. Petersburg Academy.'

PROCEEDINGS OF THE SOCIETY.

MEETING OF 11TH DECEMBER, 1878, AT KING'S COLLEGE, STRAND, W.C.
 DR. C. T. HUDSON, M.A., LL.D., VICE PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 13th November were read and confirmed, and were signed by the Chairman.

The following List of Donations received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Two dozen Slides of Insect Scales	Mr. Davis.
A Micrometer ruled with Divisions of an Inch and of a Milli- metre	Mr. J. Beck.
A Cabinet for the Society's Instruments and Apparatus	Mr. Frank Crisp.

Dr. Hudson read a paper (Dr. Millar having taken the chair *pro tem.*) on a new species of *Æcistes*, sent to him by Mr. Oxley, which he had at first named *Æ. Sphagni*, but now proposed to call by the more descriptive name of *Æ. umbella*, from its peculiar shape, which was shown by coloured drawings (see p. 1). After some remarks as to the nature of *Conochilus volvox*, which, if it could be turned inside out, would have very much the appearance of a *Melicerta*, and commending the paper by Mr. Davis upon the subject, Dr. Hudson exhibited to the meeting some beautiful coloured transparent diagrams, prepared by himself, of Rotatoria, which he showed in the darkened room by means of three duplex lamps placed behind them. The series comprised *Æcistes crystallinus*, *Limnias ceratophylli*, *Limnias annulatus*, *Cephalosiphon Limnias*, *Melicerta ringens*, *Melicerta tyro* (for which the new name of *M. Tubicolaria* was proposed), *Stephanoceros Eichornii*, *Floscularia campanulata*, *Conochilus volvox*, *Lacinularia socialis*, *Euchlanis triquetra*, *Pterodina patina*, *Actinurus Neptunius*, *Notommata aurita*, *Pedalion mirum*, *Trochosphaera æquatorialis* (from the Philippine Islands), and *Nais digitata*. The exhibition was accompanied by brief remarks, in the course of which Dr. Hudson observed that he thought that Mr. Bedwell in his excellent paper on *Melicerta* had credited that creature with rather more intelligence than it deserved. Mr. Bedwell had stated that when a particle came down to the mouth, it descended upon a kind of elastic cushion, and he had credited this cushion with a discriminating power such that the moment an object touched it there was an instant decision and disposal of it, and it was taken in or passed to the right or left or rejected according to its nature and fitness for food or building purposes. For his own part, he doubted this explanation of the phenomena, for the reasons mentioned in his paper. A curious instance was also related of what seemed very like intelligent action on the part of a specimen of *Floscularia campanulata*, which, having seized and enveloped an infusorian too large and straight to enable it to withdraw within its

case, was observed to descend in a fully expanded condition, and thus to set free the inconvenient prey.

The thanks of the meeting having been voted by acclamation to Dr. Hudson for his very interesting communication and exhibition, he resumed the chair.

Mr. Badcock thought that the name proposed by Dr Hudson, *Æcistes umbella*, was a very appropriate one. He had found the animal on April 4th, 1876, at which time he showed it to Mr. Oxley and others. It was the speciality of the umbrella-like structure which first drew his attention to it.

Mr. T. C. White inquired if the forms which had been exhibited were from fresh or brackish water?

Dr. Hudson said that all those they had seen were from fresh water.

Mr. F. H. Ward read a paper, "Improvements in the Micro-spectroscope" (see vol. i. p. 326).

Mr. Thomas Palmer said that, as far as the mode of measurement was concerned, he thought he could claim priority in the use of a photographed scale, as about three years ago he read a paper on the subject, and exhibited the apparatus. He should be very glad to see the micro-spectroscope improved, as he thought that it was not at present receiving a proper amount of attention, and he wished Mr. Ward every success in his endeavours to that end. In honour of their late President, Mr. Sorby, some good work ought to be done with it. If that gentleman's paper on "Vegetable Chromatology" was more read and studied, there would, he was sure, be more workers with the instrument than at present.

Mr. Crisp said that, in justice to Mr. Ward, the meeting should be reminded of the exact words of the paper which referred to the scale, and which he read (see vol. i. p. 329, lines 4-6). Apart from the question of the slit, Mr. Ward was entitled, he thought, to credit for the use he had made of the comparison prism. The Fellows would remember that he exhibited it at the May scientific evening, when great interest was taken in it.

Mr. Ward said he had tried to find out who was the originator of the scale, but had not been successful in doing so, though he knew it was not new, and had been in use for a long time in Germany: he was not aware that Mr. Palmer claimed it.

Mr. Crisp explained the points of his paper, "On some Recent Forms of Camera Lucida," a drawing of that of Dr. Hofmann being enlarged upon the black-board by Mr. Stewart (see p. 21). Mr. Crisp observed that there had been this year a glut of these instruments, as there were now four before the Society, viz. Hofmann's, Pellerin's, Swift's, and Russell's.

Dr. Millar said that the form last mentioned was one devised by Dr. Russell, of Lancaster, a brief description of which he then gave, illustrated by a drawing on the board.

Mr. Beck said that Mr. Crisp was quite right in saying there was

a glut of these instruments. As to this new one of Hofmann's, he could not see what the special advantage of it was. In the first place they had to take out the eye-piece because the reflecting surface was so far from it that they could not get any vision with it in its place. This he thought was a great disadvantage. Then, again, how was it proposed to see the pencil point? The rays were thrown on a piece of glass (A), (see Fig. 2, p. 21), and reflected to (B), and from that were reflected through the aperture (E). The observer at (E) looked through a piece of plate glass with two surfaces, and somewhere on the ground—upon the scale on which the drawing was made—he would see the object. If they did not mind the loss of light, they could get all the advantages claimed, by simply making a hollow Wollaston's camera; but in both cases they had the disadvantages of looking through two surfaces of glass, and a great loss of light. With all the changes which had been made at different times, he still believed that if persons would be careful to split the ray by looking with half the pupil only, and would also take the trouble to properly modify the light, there was nothing better than the old form.

Dr. Hudson said that as one who very frequently drew objects from the Microscope, he could only say that for such drawings as his of living objects the camera lucida was nearly useless. The method he adopted was to have a piece of glass ruled in squares, which covered the field of view; and, having ruled paper always at hand, the object was drawn square by square: and even the most active rotifer would sometimes remain quiet long enough to get the outline correctly. With an inanimate object he could not conceive anything more easy than this method, even to an indifferent draughtsman.

Mr. Ingpen said that Hofmann's camera appeared to be identical with one by Amici, which was forty years old at least. If the piece of glass (B) were extended, it would be the same exactly.

Mr. Crisp said it was only within the last few months that Dr. Hofmann had removed part of the plate of glass (B), the restitution of which would make the camera the same as Amici's, according to Mr. Ingpen's statement. In the drawing of this non-microscopic form, which appeared lately in 'Nature,' it was shown according to its original design.

Mr. Stewart read a Note by Mr. A. D. Michael with reference to the finding of the male of *Cheyletus venustissimus* (see vol. i. p. 317).

Mr. Crisp called attention to the remarks of Professor Adams at the meeting of the Physical Society, on 9th November, on the advantages possessed by a portable form of Dietzl's diffraction apparatus when used as a polarizer for the Microscope (see p. 87).

Mr. Ingpen made some remarks upon the $\frac{1}{8}$ -inch objective exhibited by Mr. Crisp at the October meeting,* made by the Bausch and Lomb

* 'Journal,' vol. i. p. 312.

Optical Company, in which the cover correction was obtained by varying the thickness of a film of glycerine placed between the front lens and an external flat disk of glass, as described on p. 251 of the same volume. It was similar in construction to one made by Mr. Gundlach, and exhibited at a scientific evening in 1876, but showed considerable improvement. The figure and colour were excellently corrected, but the definition could hardly be considered brilliant. The cover correction was remarkably quick and satisfactory, a small alteration making all the difference between the best definition and none at all. The apparent angle of aperture was very large, but he thought part of it was "spurious," probably owing to reflection from the edge of the glycerine film. The working distance was inconveniently small, and as the adjustment was made inside the objective, it was close for very thin as well as for thicker covers. The method of correction was a very interesting one, and one which he thought might hereafter form a new point of departure in the construction of objectives.

Mr. Beck said that the Fellows would remember that recently a question was raised by the American Microscopical Congress as to whether the aliquot parts of an inch or of a metre should be used as a universal standard of microscopical measurement, and he then ventured to suggest that they should give the matter their attention. He had considered it, and he certainly should recommend that the divisions of the metre should be adopted. It was asked at the time whether the scales of the divisions of the millimetre could be obtained in the event of their being required; and having turned his attention to the matter, he had arranged a micrometer in which both scales could be seen. Having ruled a fiducial line, they had ruled on one side of it $\frac{1}{100}$ and $\frac{1}{1000}$ of an inch, and on the other side the $\frac{1}{100}$ of a millimetre, so that having the two scales on one slide there would be no longer any necessity for changing the slides every time they wanted to make a comparison. There would be a further advantage in having the two scales in this way for comparisons, because if there should happen to be any error or imperfection in the instrument used for ruling, it would be common to both scales. He had much pleasure in presenting one of these scales to the Society, and if any Fellow found anything which could be improved he should be happy to adopt the suggestion.

A Discussion took place between Mr. J. Mayall, jun., and Dr. Edmunds, as to the immersion prism referred to by the latter at the October meeting (vol. i. p. 309), and which Mr. Mayall claimed to have been originated and suggested by him, a claim which Dr. Edmunds on the other hand disputed.

The following were exhibited:—

Dr. Hudson:—Seventeen coloured transparent drawings of rotifers.

Mr. F. H. Ward:—(1) The micro-spectroscope and apparatus

referred to in his paper, and (2) two sections of broom, double stained by himself, which were much admired.

Dr. Millar:—The camera lucida devised by Dr. Russell.

Mr. Crisp:—(1) Hofmann's camera lucida. (2) Swift's ditto. (3) Dietzl's diffraction apparatus. (4) Stein's Infusoria, Part III. (the Flagellata). (5) Micro-photographs of botanical subjects, by De Bary.

Mr. J. Mayall, jun.:—(1) His two modifications of Dr. Woodward's "new device," in which the four exposed surfaces of the prism are utilized by cutting them at various angles, so as to approximate the angle of the illuminating rays to the semi-aperture of the objective likely to be used. One is an ordinary prism so cut, but with circular top for convenience of rotation, and mounted at the end of a brass tube with wide slots for the free intromission of light perpendicularly to each face. The other is a nearly hemispherical lens with the four faces cut on the spherical surface, and mounted on a rod attached to the centre of this surface. (2) A nearly hemispherical lens and a small semi-cylinder mounted conveniently for immersion illumination.

New Fellows:—The following gentlemen were elected Fellows of the Society:—Edwin W. Alabone, M.D., M.R.C.S., and John Simpson Harrison, Esq.

MEETING OF 8TH JANUARY, 1879, AT KING'S COLLEGE, STRAND, W.C.
J. W. STEPHENSON, ESQ., F.R.A.S. (TREASURER), IN THE CHAIR.

The Minutes of the meeting of 11th December were read and confirmed, and were signed by the Chairman.

The following List of the Donations received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Abbe, Dr. E.—Die Optischen Hilfsmittel der Mikroskopie. (Extracted from 'Bericht über die wissenschaftliche Apparate auf der Londoner Internationalen Ausstellung im Jahre, 1876')	<i>The Author.</i>
Badham, Dr. C. D.—The Esculent Funguses of England. 2nd ed. 1863	<i>Mr. Frank Crisp.</i>
Cooke, Dr. M. C.—Grevillea. Vols. I.–VI. 1872–8	<i>Ditto.</i>
Deby, Julien.—De la recherche Microscopique du Sang au point de vue Médico-legal. 1876. (Extracted from the 'Annales de la Société Belge de Microscopie')	<i>The Author.</i>
" " Ce que c'est qu'une Diatomée. 1877. (Extracted from the 'Bulletin de la Société Belge de Microscopie' for 1877), and five other papers	<i>Ditto.</i>

The Chairman having requested the Fellows to appoint two auditors of the accounts for the past year, Mr. Goodinge (proposed

by Mr. Curties, and seconded by Dr. Matthews), and Mr. Curties (proposed by Mr. Guimaraens, and seconded by Mr. Michael), were duly elected.

Mr. Stewart gave a *résumé* of a paper by Mr. W. J. Sollas, M.A., F.G.S., "Observations on *Dactylocalyx pumiceus* (Stuchbury), with description of a new variety, *D. Stuchburyi*," the chief points of interest in which were illustrated by diagrams drawn upon the black-board. The photographs and drawings which accompanied the paper were also handed round for inspection. (This paper will appear in the April number.)

Dr. Matthews said that he had been giving a good deal of attention lately to the subject of corals, madrepores and allied forms, and on examining them he thought he had found some evidences of parasitism. At the base of each of many specimens, he had found that there was a rough mass of stony material which he at first cast aside. Some time afterwards he was led to examine these parts in the hope of finding diatoms or foraminifera upon or in them, and he then discovered the curious fact that each coral was more or less based upon a sponge, and that it appeared to be a real case of parasitism. He at first thought that he had made a discovery, but further inquiry showed that there had been a paper written upon the subject by Mr. Carter.* He (Dr. Matthews) found that this state of things was shown in nine cases out of ten of the specimens examined by him. There were, however, some other specimens which displayed clear evidence of having been bored by a sponge. He had also found that certain sponges had become associated with some of the madrepores in such a manner, as to suggest the idea of a kind of mutual parasitism or commensalism, and also that in some cases the whole sponge had become enclosed and the cavity filled by sarcode and gemmules, the whole being fused together in such a way that it was hardly possible to tell by the Microscope where the gemmules ended and the corallum began; in fact, the fusion of the two seemed very complete and extraordinary, the thin layer of corallum extending completely over the sponge. He had found also some foraminifera, but had not yet had time to examine them. Mr. Carter in his paper did not mention any coral larger in size than $\frac{1}{4}$ inch, and this was described as being wholly on the surface of the sponge. He thought the matter was worth mentioning, and although it might be only one fact added to the great heap, it might some day be of use when dealt with by other hands.

Mr. Stewart said that very commonly before these corals arose as a branching stem they spread out in a thin layer, from which the corallum afterwards arose. They were very often fixed to a loose kind of oolitic rock, which was very friable and easily broken down, and it was easy to imagine how this kind of cap might involve a sponge. If what had been described occurred in this manner, he should hardly be disposed to call it a case of parasitism. In some kinds, however, such as the *Hyalonema* or glass rope sponge, they

* See vol. i. p. 288.

frequently met with a kind of true parasitism. It was also quite a common thing to find *Hydrozoa* and other things attached to the sponges.

Dr. Matthews said that he spoke with diffidence on the question of parasitism. He had a number of specimens to show after the meeting, and which he thought would help to elucidate the question.

On the motion of the chairman, a vote of thanks was passed to Mr. Sollas for his paper, the chairman saying he thought it had not been of any less interest from having been the means of eliciting the very interesting communication of Dr. Matthews.

Dr. J. Edmunds read a "Note on a Revolver Immersion Prism for Sub-stage Illumination," the subject being illustrated by diagrams, and by the exhibition of the apparatus described (see p. 32). A discussion ensued between Mr. Lettsom, Mr. Mayall, and Dr. Edmunds.

Mr. John Mayall, jun., read a paper "On Immersion Illuminators," various kinds of which he exhibited in illustration of the paper (see p. 27).

The Chairman inquired if Mr. Mayall had tried mounting objects otherwise than in balsam, because it appeared to him that water might be a very good medium.

Mr. Mayall said he had been working mainly upon objects in Canada balsam, but he had some time ago the opportunity of examining some of Professor Tyndall's bacteria, which were in water, and he then saw very clearly with the immersion what Mr. Dallinger had the greatest difficulty in making out.

The Chairman thought that the greater difference between the refractive index of diatom silica and water, as compared with balsam, would probably render the structure more visible if water was used.

Mr. Mayall said he remembered to have observed that such was the case.

The Chairman said that they had another paper by Mr. Mayall, "The Aperture question," and one by himself, "On a Catoptric Immersion Illuminator" (see p. 36), which must be taken as read, owing to the press of business before the meeting.

Mr. Crisp explained the views of Mr. Julien Deby in the paper he had sent entitled "Is not the rotiferous genus *Pedalion* of Hudson synonymous with *Hexarthra* of Ludwig Schmarda?" Dr. Hudson's drawings of *Pedalion* and that of Schmarda being laid before the meeting.

Mr. Stewart read part of a paper by Mr. Kitton, on "The Thallus of Diatoms," accompanied by comments on the views expressed by Dr. Lanzi and Mr. Kitton (see p. 38).

Mr. Crisp gave an account of the observations of Professor Graber, of Czernowitz, on some new sense-organs (supposed to be auditory)

in insects, and suggested that they would form a highly interesting subject for the further examination of microscopists, the more particularly as Professor Graber stated that for want of time he had been unable to complete the observations that required to be made in order to establish their exact character. The organs described were drawn on the black-board by Mr. Stewart (see p. 45, and Plate IV. Figs. 1, 1 *a*, 1 *b*, 2, and 2 *a*).

Dr. Matthews inquired if the hairs were supposed to perform the function of otoliths.

Mr. Stewart regarded the mode of nerve-termination of these organs as presenting the closest resemblance to that of the human auditory apparatus. He thought there seemed in all cases a special provision to prevent the otolith from touching the hairs. If they examined it in the bony fish they would find that there was an otolith convex on the side facing the brain, and this would come in contact with the hairs, but for the fact that they also constantly found deep grooves, which seemed as if they were to ensure that the otolith should be in as close a connection as possible without resting upon them.

The Chairman proposed a vote of thanks to Mr. Crisp for his very interesting description of the important observations referred to, and to the authors of the other papers which had been read that evening, which was carried unanimously.

The List of Fellows nominated for election as members of the Council at the ensuing annual meeting, was read in accordance with the 44th bye-law.

The following objects were exhibited:—

Mr. Ingpen:—(1) An old camera lucida, of the form designed by Amici, in which the image of the object is twice reflected, first by an opaque, and then by the first surface of a transparent mirror; the method being identical with that of Dr. Hofman described at the last meeting. (2) Also another, by Amici, in which the image of the object was reversed by a right-angled prism.

Dr. Matthews:—Specimens exhibiting parasitism of a coral on a sponge.

Mr. F. H. Ward:—Sections of mistletoe from an apple-tree—double stained.

Mr. Crisp:—(1) The Sorby miniature micro-spectroscope (see p. 81). (2) Recklinghausen and Meyer's pathological micro-photographs. (3) Specimens of microscopic printing issued by the Security Printing Company. (4) Muhr's "Wall Charts" of the anatomy of the head of insects.

Mr. Heneage Gibbes was elected a Fellow of the Society, and five gentlemen were proposed for election at the next meeting.

WALTER W. REEVES,
Assist.-Secretary.

Vol. II. No. 2.]

APRIL, 1879.

[To Non-Fellows,
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JOURNAL
OF THE
ROYAL
MICROSCOPICAL SOCIETY;
CONTAINING ITS
TRANSACTIONS AND PROCEEDINGS,
AND OTHER INFORMATION AS TO
INVERTEBRATA AND CRYPTOGAMIA,
EMBRYOLOGY, HISTOLOGY, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by
FRANK CRISP, LL.B., B.A., F.L.S.,
ONE OF THE SECRETARIES OF THE SOCIETY.



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VOL. II. No. 2.

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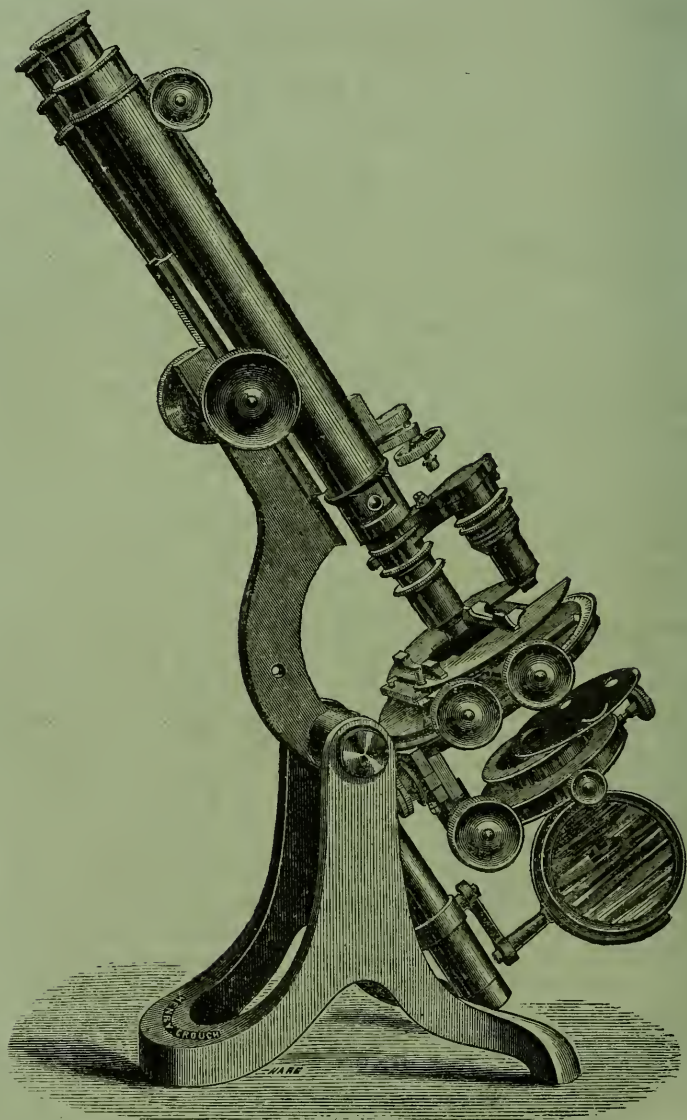
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OBJECTIVES, AND ACCESSORIES.



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TRANSACTIONS OF THE SOCIETY.

IX.—*The President's Address.* By H. J. SLACK, F.G.S.

(Read 12th February, 1879.)

I AM, unfortunately, quite unable to follow in the footsteps of Mr. Sorby, who, upon two occasions, brought before you in his Annual Addresses important original work, highly gratifying to those who value and desire to increase the scientific standing of this Society. Failing in this, it seemed most desirable to select a few points of interest for your consideration, arising out of recent invention and observation.

First, I would mention the introduction of the oil lenses suggested by Mr. Stephenson, and constructed under the direction of Professor Abbe by Herr Zeiss, of Jena. The objects of this invention are twofold; first, to do away with the troublesome necessity for making corrections with the screw collar introduced by Andrew Ross, and secondly, to obtain the largest angle of aperture with a good working distance. By selecting an oil, or mixture of oils having the same refractive power as the covering glass, it was expected that a fixed correction would suffice for any thickness. When the cover was thicker, as the working distance of the objective remained unchanged, there would be a thinner stratum of oil used upon the immersion principle, and when the cover was thinner the oil stratum would be thicker. After many trials, Professor Abbe found oil of cedar wood had very nearly the requisite properties when the illumination was with oblique light, and was improved for direct light by an admixture with oil of fennel seed. The glass made for Mr. Stephenson fully answered expectation. It had according to his description a balsam angle of 113° , its power was rather more than one-ninth, and the only correction it needed was a change in the length of the Microscope tube from 10 inches to 12 when very thin covers were employed. One result of using objectives of this construction, taken in connection with Professor Abbe's account of the way in which

lined objects can be viewed, or lined appearances produced, has been to throw fresh doubt as to the correspondence between actual structure, and optical effects of this description; and we are thrown back, as I pointed out in reference to insect scales long ago, upon the necessity of making various experiments, and of reasoning from the best analogies we can obtain in the interpretation of the appearances we see. Amongst those who have experimented with the oil lenses I may mention Dr. Pigott, who speaks of a No. 15 as a "magnificent glass."

It was not found by Mr. Dallinger, whose researches require the highest and most efficient optical aid, that the oil objectives showed anything he could not see with the Powell and Lealand glasses he usually employed, but he at once admitted and praised the great facility with which they could be used. He has since obtained excellent effects by using oil of cedar wood with Powell and Lealand's newest $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$, and expresses great admiration for a new wet and dry $\frac{1}{50}$ by the same makers.

By the kindness of Mr. Baker, I had an opportunity of trying an $\frac{1}{8}$ and $\frac{1}{12}$. The latter I found a splendid glass, remarkable for the ease with which it displayed difficult objects, and requiring only a film of oil to connect it with the slide cover. The $\frac{1}{8}$ had such a large working distance that it required a little puddle of the oil, and on this account could only be employed with the Microscope in a vertical position. I am told that these glasses are not all alike in this respect.

The 'American Quarterly Microscopical Journal' for January, 1879, contains a letter from Professor Abbe, explaining that owing to a mistake several $\frac{1}{8}$ ths have been made with a balsam angle of 107° to 109° only, instead of 114 to 116 , as they should have been. He also states these objectives are composed of "four separate lenses," and not three, as Professor H. L. Smith supposed.

It seems probable, from Mr. Dallinger's experiments, and a few made by myself, that opticians may be able to furnish us with objectives that can be corrected for either oil or water; but if this cannot be satisfactorily accomplished, it is not likely that the oil lenses will supersede the water ones, though they have obviously some decided advantages for special purposes.

The fine performances of the large-angled glasses of the best makers, and the results obtained with the extreme angles of the oil lenses, have led in some quarters to a belief that great angles are good for all purposes; but there can be little doubt that this will be found a mistake, and that glasses of small and moderate angles, with fine corrections, will still be needed for much, and probably for most, valuable work.*

* See Dr. Pigott's paper "On the Invisibility of Minute Refracting Bodies caused by Excess of Aperture," 'M. M. J.,' February, 1875, p. 55.

Mr. Dallinger has pointed out that fine dry lenses are still necessary for many cases in which the use of fluids is objectionable, and this brings us to the consideration of the direction in which we must look for further progress.

It is now several years since Dr. Pigott called attention to the practical importance of the residual errors of the best objectives then made, and he proved experimentally that with the existing materials it was possible to reduce them. Since then important advances have been made, both with dry and wet lenses, and it is probable that for a further advance, to any important extent, the optician must be supplied with fresh materials.

Professor Abbe says, "The impossibility of removing each chromatic difference of spherical aberration has its root in the circumstance that, in the kinds of crown and flint glass at present provided, the dispersion always goes hand in hand with the mean index of refraction, in such a way that the higher dispersion is attached to the highest index. The outstanding aberrations might be completely, or very nearly, compensated, if an optical material were provided in which a relatively lower refractive index were united with a higher dispersion, or a higher refractive index with a relatively smaller dispersion. It would then be possible by combining such materials with the ordinary crown and flint glass to remove the chromatic and spherical aberrations which are partly disconnected, and thus fulfil the essential conditions arising from the chromatic difference."*

Professor Abbe also remarks upon the very small number of persons engaged in the manufacture of glass for optical purposes, and upon the few substances that have hitherto been employed in its preparation. Looking to the present conditions of manufacturing industry, which offer the largest gains to those who can produce at the lowest price articles required in great quantities, it is not probable that purely commercial considerations will induce anyone to devote attention to the demands of science for new kinds of glass or substitutes for glass, and the task is not likely to be undertaken unless through the help of private munificence, or State aid.

Besides glasses, which are chiefly silicates of potash, soda, and lead, with a little alumina or lime, &c., there seems a probability that a class of compounds resembling precious stones may come into optical use. M. Feil, a celebrated manufacturer of optical glass, and M. Fremy have succeeded in artificially producing rubies and sapphires, alumina minerals of high refractive power, and it is not impossible some quite new compounds may be formed. When Sir David Brewster experimented with jewel lenses, he spoke very highly of garnet, which is a compound of three or four silicates, chiefly of

* 'Die Optischen Hilfsmittel der Mikroskopie,' von Dr. E. Abbe, Professor un der Universitat zu Jena. Braunschweig, 1878.

alumina and lime. If the optician were supplied with fresh substances possessing the requisite properties, we might not only have objectives of more perfect corrections, but higher powers with flatter curves and larger lenses.

Passing from objectives to their employment and performance, we find Professor Abbe dealing with the conditions necessary for the resolution of close-lined and analogous objects, Mr. Dallinger measuring the flagella of *Bacterium termo* and finding them less than the 200,000th of an inch, and Dr. Pigott exhibiting, by remagnification, the image of a spider line diminished to the one-millionth of an inch.

If we consider the application of high powers to natural history, it is an interesting question how far the existing optical means enable the structure and rank of many of the minuter organisms to be discovered, and how far down in the scale sexual generation can be affirmed, or, with probability, assumed.

Professor Haeckel places amongst his Protista, eight classes of creatures, including Amœba, Flagellata, Diatoms, &c., and affirms of the whole list "that the most important physiological characteristic of the kingdom Protista lies in the exclusively non-sexual propagation of all the organisms belonging to it."* With regard to this statement, it may be mentioned that in 1863 Dr. Wallich published a remarkable series of observations on the form of Amœba he discovered in a Hampstead pond, and named *villosa* from its having a permanent villous organ protruding from one part. He stated that "one of the most remarkable amongst the most novel and varied characters of the Amœbæ consists in the vesicle, in which the true nucleus is contained, having been found to be distinctly membranous in some individuals." He noticed also "a clear nucleolus," and inquired whether the appearances presented justified the belief that the creature possessed "a germ cell and sperm cells."†

In April, 1875,‡ Messrs. Dallinger and Drysdale described a series of facts in the life-history of certain flagellate monads, including a sexual union, a division of nucleus, and formation of germs at first so minute as to be separately invisible, and then developing by several changes into the parental form. A magnification of 2600 diameters sufficed for watching these processes, and made the nuclei appear about one-eighth of an inch in their shortest diameter. One of the creatures in its most globular condition had, with that power, an apparent longest diameter exceeding one inch, and the shorter diameter a little under an inch. If we compare these dimensions with those of *Bacterium termo* magnified 4000 diameters, in Mr.

* 'History of Creation,' vol. ii. p. 69.

† 'Ann. N. H.,' May, 1863.

‡ 'M. M. J.,' May, 1875.

Dallinger's drawing represented in the September number of the new Journal,* we find the latter creature's body composed of two oval beads, each one seeming only about the size of the nucleus of the just mentioned flagellate monad, though the magnification is 1400 diameters greater. How much smaller living creatures may exist it is not possible to say, but with those of these dimensions we can scarcely expect any mode of vision furnished by the Microscope to enable the processes of their germ formation to be traced. Another difficulty of dealing with these organisms arises from the fact that it is only by unintermittent watching for a long time and under a variety of conditions that the whole cycle of their life changes can be made known. Mr. Dallinger has shown in the case of monads that the same species in different stages of development present very different aspects and behave in very different ways. The minute bacteria found to be capable of producing in animals the splenic disease which the French call *sang de rate*, has been found by other observers able under certain conditions to branch like the mycelium of a mould; and in M. Pasteur's book '*La Bière*' will be found many illustrations of dissimilar growths of ferments, and fungi under different circumstances. After recounting many interesting experiments, M. Pasteur remarks that in the dust of a laboratory in which fermentations are studied, there are many germs which give rise to organisms which it is impossible to distinguish from alcoholic ferments, although they do not possess the properties of those bodies.

In endeavouring to avoid the error of lumping together a number of small organisms under a common heading, implying a very low stage of development, attention should be paid to any indications that may be obtained from their external organs, although their internal structure may defy scrutiny. An organism furnished with cilia in constant vibration is in that respect, and may be in others, below another in which ciliary motion, to use the words of the '*Micrographic Dictionary*,' "is interrupted at intervals, apparently under the influence of a will." Of course, the term "will" is only employed to express a remote analogy. The difference appears to be that the ceaseless motion in one case responds to some continuous necessity, possibly that of respiration, while the intermittent one responds to a less frequent need, such as going in search of food. The "springing monad" of Messrs. Dallinger and Drysdale,† so called from its peculiar habit of coiling and uncoiling one of its flagella with a darting motion, not unlike the vorticella, carrying the body with it, evidently possesses an instrument superior to the simple cilium, and the same may be said of the "hooked monad" of these observers, a creature "with a persistent hook-like flagellum." The "calycine monad," to

* '*Journal R. M. S.*,' vol. i. No. 4.

† '*M. M. J.*,' vol. x. p. 245.

which reference has already been made, is in its normal state like a cup, terminating in a slender pointed stem. It has nuclear bodies and two large "eye spots," with the strange "rhythmical opening and shutting" seen by these observers in some other monads. It is provided with four long flagella, and the authors say, its mode of locomotion is "a graceful gliding through the water, the flagella moving so often and so rapidly as to render their detection impossible when the monad is at its swiftest. They could roll over on their long axis, and change the direction of their motion with lightning-like rapidity, and, however crowded the field, not the slightest approximation to collision occurred." In this case the creature is big enough for some important internal organs to be seen, but had it been too small for this, or had none been open to detection, would not its remarkable and varied powers of locomotion have afforded fair ground for suspecting that it ought not to be ranked among the simplest unicellular bodies?

Before passing to another topic, a protest may be admitted against a not uncommon practice of describing some of the lowest living things as composed of a little mass of "homogeneous protoplasm." Is it not true, whenever magnification reasonably proportioned to the size of any organism can be applied, its protoplasm, so far from being "homogeneous," exhibits granulation, or particles differing in refractive power, and presumably in chemical properties from the mass?

The progress of discovery certainly leads to the belief that the processes and functions of the higher animals are developments of what is found low down in the scale. In a lecture "On the Phenomena of Life common to Animals and Plants,"* Claude Bernard said, "the principle of vital unity dominates in the entire history of animals and plants," and he characterized "nutrition" as "continuous generation." In another passage he said, "At the origin of every nutritive or generative phenomenon there is an organized agent, egg, germ, cell," and up to the present time the Spontaneous Generation Controversy has resulted in showing that there are no known means of obtaining any manifestations of new life, excepting as the products and results of previous life, acting, and acted upon, by appropriate surroundings. There is, however, another controversy still going on, in which the Microscope is indispensable, which has very wide and important bearings upon a variety of scientific questions, and which has a better chance of being finally settled.

This controversy relates to M. Pasteur's explanation of certain facts and appearances belonging to fermentation. In 1861, and since, M. Pasteur has been led by various experiments to divide a group of living organisms into two classes, which he designates *aerobies* and *anaerobies*, the former requiring for their existence

* 'Revue Scientifique,' 26th September, 1874.

and growth the presence of free oxygen, and the latter able to dispense with it, provided they are brought in contact with a fermentable substance from which they can obtain the oxygen they need by a process of decomposition—the latter, he affirms, to be ferments. Septic vibrions he finds killed by free oxygen, and these come under his designation of *anaerobies*. In other cases, and notably in yeast plants, he notices a capability of living in either state; and in the last or *anaerobic* one, they act as ferments.

Before proceeding further with M. Pasteur's researches, it will be well to bear in mind what takes place in the life processes of the higher chlorophyll-containing plants, and we shall then be able to see what relation these *aerobies* and *anaerobies* bear to them.

The experiments and observations of M. Corenwinder, extending and confirming opinions expressed by M. Th. de Saussure, and supported thirty years ago by M. Garreau,* show that the respiratory process of plants is constant, and like that of animals carried on by absorption of oxygen and exhalation of carbonic acid, and that the absorption of carbonic acid with retention of carbon and emission of oxygen is "a veritable digestion." The respiratory acts belong to the nitrogenous matter of the plants, and the carbon digestion to the chlorophyll, and it depends essentially upon the influence of light, being most active during direct exposure to solar rays and diminishing as the light is weakened. The carbon carried off in the respiratory action comes from the supply obtained by the digestive and assimilative processes.

We learn from M. Pasteur that the moulds *Penicillium* and *Aspergillus*, and the "mother of wine," *Mycoderma vini*, are capable of living in either of the states named, and he describes a variety of experiments showing these facts, and he remarks upon them, "We are constrained to admit that the production of alcohol and carbonic acid with the help of sugar, in a word, alcoholic fermentation, are chemical acts connected with the plant life of cells of very divers natures, and that they appear at the moment these cells are no longer able to burn freely the materials of their nutrition by the effect of respiration, that is to say, by absorption of free oxygen, and that they accomplish their life by utilizing oxygenated substances like sugar and combustible bodies, which give out heat in their decomposition. The ferment character then presents itself to us, not as peculiar to this or that being, or this or that organ, but as a general property of the living cell; a character always ready to manifest itself, and actually doing so when its life is no longer accomplished under the influence of free oxygen, or of a quantity of that gas sufficient for all the acts of nutrition." †

M. Pasteur gives drawings of the appearance of various cells

* See 'Revue Scientifique,' 1st August, 1874.

† 'La Bière,' pp. 113, 114.

grown under the two conditions. They might be taken for different species, and no mere microscopic examination would suffice to show what they were.

Speaking of the peculiar effects of yeast and other ferments, he observes that "there is only a slight relation between the weight of the yeast formed and the weight of sugar decomposed; with all other known beings the weight of the nutritive matter assimilated is of the same order of quantity as the weight of the aliments brought into play. The discrepancy where it exists is relatively slight. Such is not the life of yeast. For a weight a of yeast formed, the weight of the sugar decomposed is $10a$, $20a$, $100a$, and even more."

The growth and generation of ferments in mineral media are regarded by M. Pasteur as having "a great physiological interest." He says, "They demonstrate, among other results, that all the protein matter of yeasts may have their origin in the vital activity of cells putting in action hydrocarbonous substances without the influence of light or free oxygen—or with free oxygen in the case of the aerobies—together with salts of ammonia, phosphates, and sulphates of potash and magnesia. It might even with rigour be admitted that a similar effect is produced in the higher plants. What serious reason can be invoked in the present state of science for not considering this effect as general? It would not be illogical to extend the results we speak of to all plants, and to believe that the protein matters of plants, and perhaps even of animals, are formed exclusively by the activity of cells acting on the ammoniacal salts and the mineral salts of the sap, or of the plasma of the blood and the hydrocarbonous matters, of which the formation in the higher plants only requires the aid of the chemical forces of green light.

"According to this view the formation of protein substances is independent of the great act of reduction of carbonic acid under the influence of light. . . . As in plant production by a hydrocarbonous matter in a mineral medium, the hydrocarbonous matter may vary greatly, and we comprehend with difficulty how it reduces itself to its elements before serving for the composition of the protein matters, we may hope to obtain as many distinct protein bodies, and even celluloses, as there are hydrocarbonous matters." M. Pasteur states that he is engaged in experiments of this description. He further remarks that if solar radiation is indispensable for the decomposition and formation of the proximate principles of the larger plants, certain lower ones can do without it, and still form a variety of the most complex substances, so that life in inferior forms might exist even if sunlight disappeared.

Objections have been made to M. Pasteur's theory of the action of ferments by various authorities, and the controversy is still going

on in the French Academy. Schützenberger, in his work on Fermentation, says, "Yeast sets up alcoholic fermentation in a solution of pure sugar in the absence of all trace of oxygen, but without developing; this is contrary to the affirmation of M. Pasteur that fermentation is bound up with the organization of the yeast, or is a phenomenon correlative to the vital activity of the cells."

Full explanations on this point are given by M. Pasteur in 'La Bière.' I will cite one passage (p. 239), in which he says, "In order to multiply itself in a fermentable medium, without the presence of oxygen gas, the cells of yeast must be extremely young, full of life and health, still under the influence of the vital activity they owe to the free oxygen which assisted to form them, and which perhaps they have stored up for a time. When older they have much difficulty in reproducing themselves without air, and they age more and more quickly: if they continue to multiply, it is under a *bizarre* and monstrous form. When still older they remain absolutely inert in a medium deprived of free oxygen. It is not that they are dead: usually they rejuvenesce rapidly if sown in the same liquid after it has been aerated."

The lines of inquiry suggested by M. Pasteur may lead to many valuable results. It is obvious that the chemist can compose a great variety of nutrient fluids in which many of the lower organisms can be grown. Certain mineral matters, compounds of ammonia to supply nitrogen, and hydrocarbons that may be varied to almost any extent, offer the means of experiments presenting different conditions and likely to lead to different results.

Unless new methods can be devised, it will evidently be a waste of time to seek amongst the simplest organisms for any transition, or change of dead matter into living matter without the intervention of a living cell; but as the highest organisms are orderly and co-ordinated aggregations of simple ones, the smallest living particle capable of growth, reproduction and decay, may, when rightly questioned, elucidate some of the profoundest problems with which the biologist has to deal.

X.—*Observations on Dactylocalyx pumiceus* (Stutchbury), with a Description of a New Variety, *Dactylocalyx Stutchburyi*.

By W. J. SOLLAS, M.A., F.G.S., &c., &c.

(Read 8th January, 1879.)

PLATES V., VI., VII., AND VIII.

THE specimens of *Dactylocalyx* which came under the examination of Stutchbury were two, both of which belonged originally to the Bristol Museum; of these, one, a very fine and complete vasiform example, is still preserved there intact; of the other, which is the describer's type, the Bristol Museum only possesses a part, the other part, comprising a half of the originally vasiform specimen, together with a piece broken from the remaining half, having been exchanged with the British Museum for a half of a specimen of *Hyalonema japonica* (Grey).

Thus there now remains at Bristol a complete specimen of *Dactylocalyx*, together with a fragment of the type, and having had occasion, while arranging the collection of sponges in the Museum, to examine this material anew, I came across some fresh facts relating to it which appear to me worth recording.

DESCRIPTION OF THE PLATES.

PLATE V.

- FIG. 1.—*Dactylocalyx pumiceus*; var. *Stutchburyi*. Lateral view. $\times 0\cdot321$.
FIG. 2.—The same, seen from above. $\times 0\cdot31$.

PLATE VI.

- FIG. 1.—*Dactylocalyx Stutchburyi*. Seen obliquely from below. $\times 0\cdot37$.
FIG. 2.—A lantern-spine, supporting an acerate spicule; the ends of the spicule are not represented in the drawing. $\times 50$.
FIGS. 3 and 4.—Similar, but more usual form of lantern-spines, exhibiting their ordinary reticulate character. $\times 50$.
FIG. 5.—Sexradiate spicule, from the surface of the perforating tubule in *D. Stutchburyi*. $\times 50$.
FIG. 6.—Quadriradiate spicules, common in the dermal layer of *D. Stutchburyi*. $\times 50$.

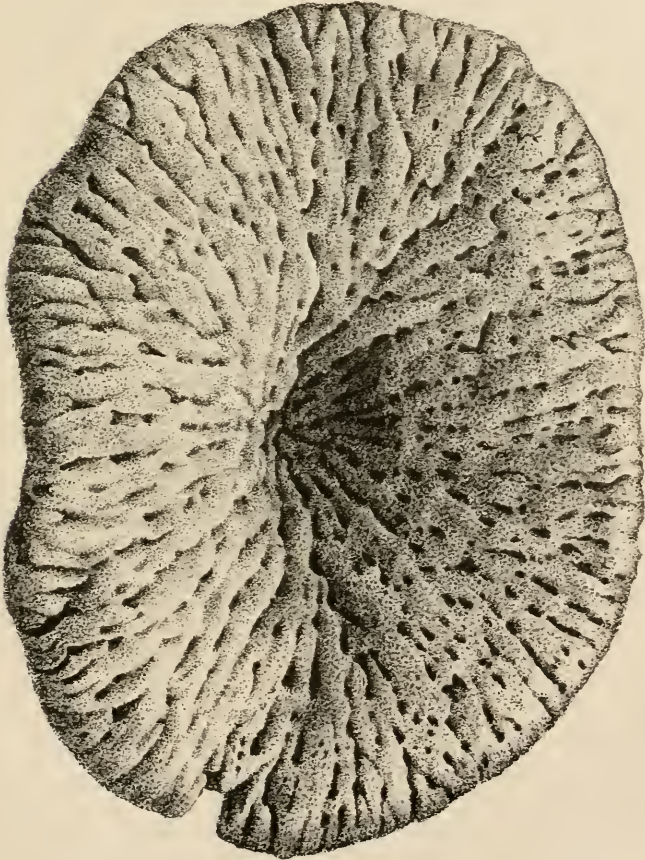
PLATE VII. (*Dactylocalyx pumiceus*).

- FIG. 1.—Fusiform acerate spicule of the outer surface $\times 15$; *a*, middle of spicule $\times 150$.
FIG. 2.—Sexradiate dermal spicule with distal ray suppressed. $\times 50$.
FIG. 3.—Smaller acerate spicule, capitate at both ends. $\times 25$.
FIG. 4.—Sexradiate dermal spicule, with one of the horizontal arms bent backwards, and all except the proximal ray with capitate ends. $\times 50$.
FIG. 5.—Typical sexradiate of the dermal layer. $\times 50$.
FIG. 6.—Sharply-spined fibre of the secondary network. $\times 100$.
FIG. 7.—Secondary network formed on a framework of large sexradiate spicules. $\times 50$.
FIG. 8.—Dermal sexradiate, with long, wavy, branched rays. $\times 50$.
FIG. 9.—Small sexradiates, from the interior of the body-network; *a*, with pointed, *b*, with capitate ends. $\times 50$.

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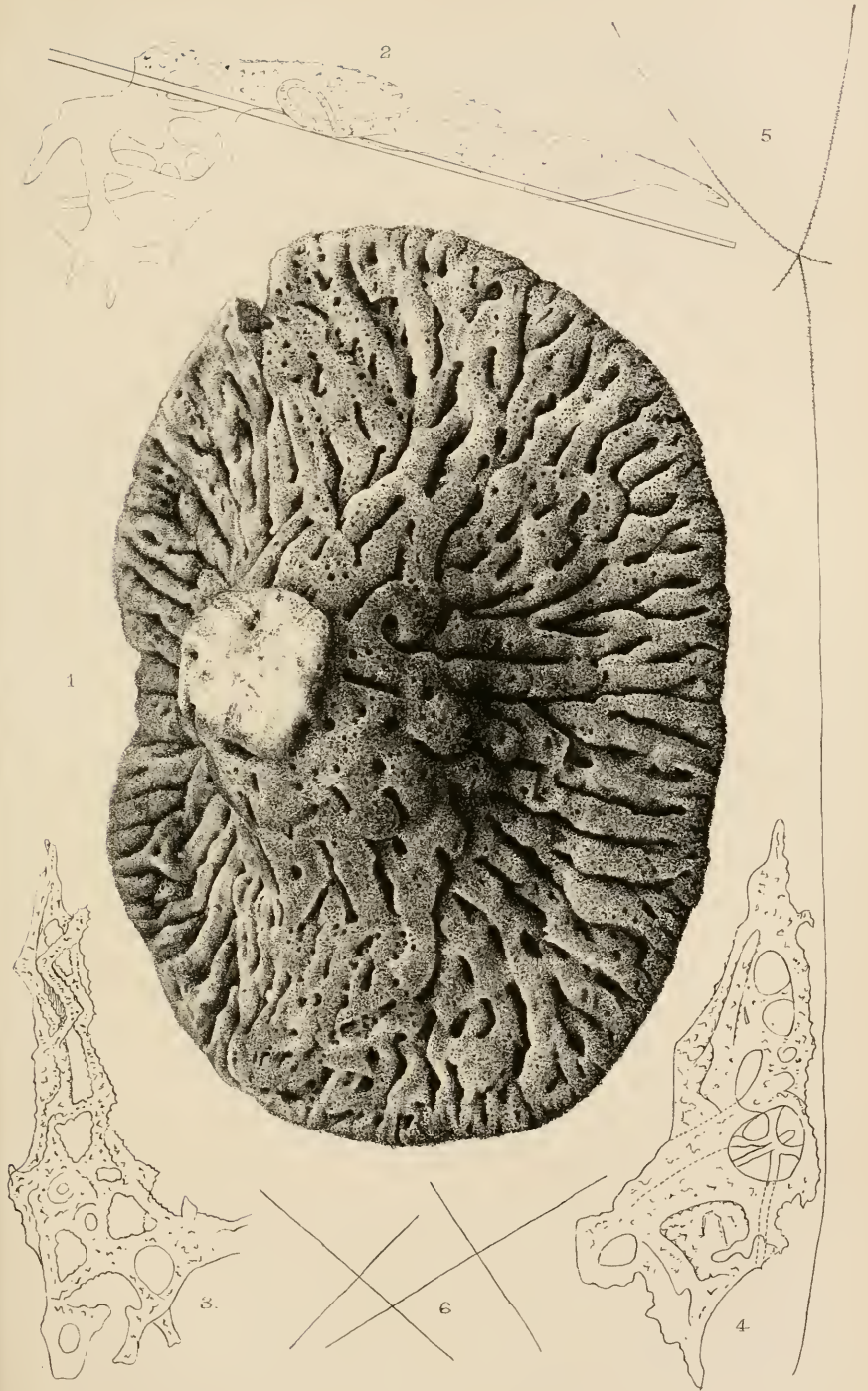
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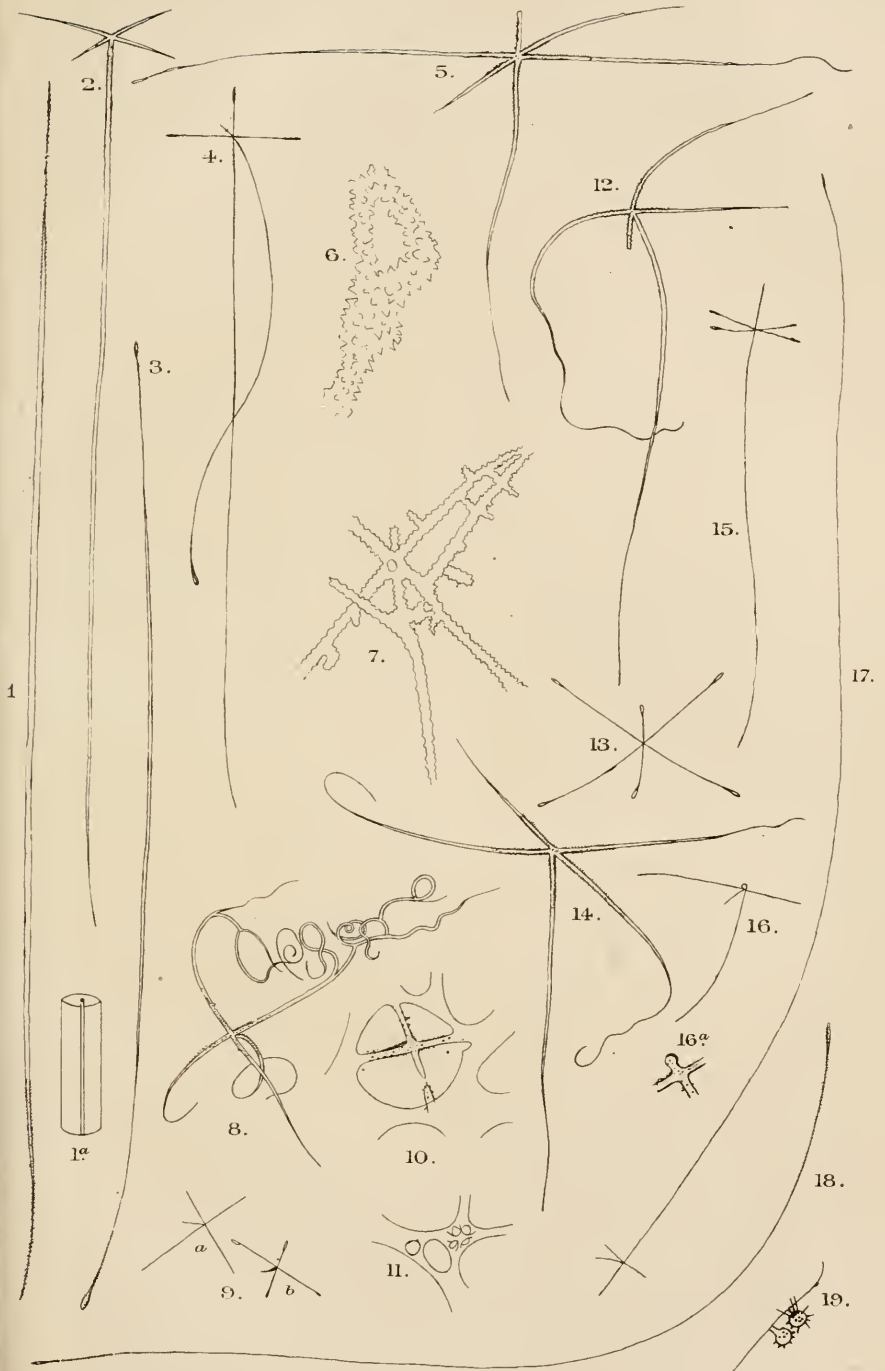


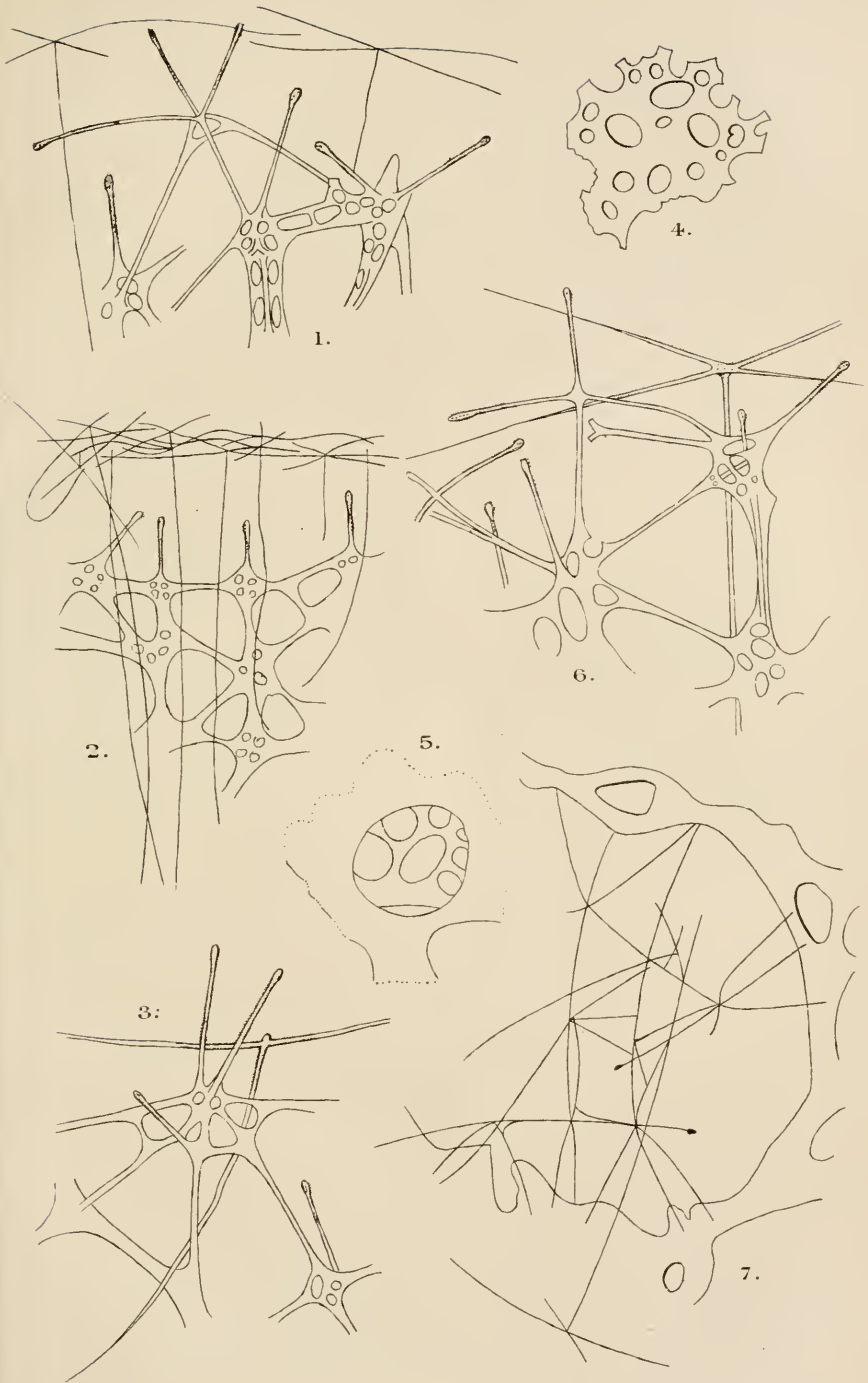
From a Photograph.

Mintern Bro^s imp.

Dactylocalyx Stuchburyi (Sollas.)







WJ Sollas del.

Mintern Bro^s imp.

Spicules of *Dactylocalyx pumiceus* & *D. Stuchburyi*.

Dactylocalyx pumiceus (Stutchbury).*

Outer surface.—The under or outer surface of this widely expanded vasiform sponge is folded into a number of ridges and deep grooves, which radiate in an irregular sinuous fashion from the base towards the edge of the vase, the ridges frequently anastomosing laterally in their course, so as to circumscribe the grooves, which thus seldom extend continuously for more than 2 inches in length, and never beyond $2\frac{1}{2}$ inches. The greatest depth attained by these channels is $\frac{1}{16}$ ". The exterior of the ridges is marked by circular openings from which more or less cylindrical tubes are continued inwards into the sponge at right angles to its surface; these tubes either open directly into the excurrent canals which we shall mention presently, or more frequently, after branching once or twice, lose themselves in the large meshes of the skeletal network.

On the inner surface of the cup a number of round holes occur, each elongated a little in a radiate direction, looking obliquely

FIG. 10.—Spicule involved in siliceous material, which has failed to completely invest one ray. At the point where the ray has been left bare it appears to have been reabsorbed, so that its extremity is quite disconnected with the centre of the spicule. $\times 50$.

FIG. 11.—An octahedral node of the young fibre. $\times 50$.

FIG. 12.—Dermal sexradiate spicule. $\times 50$.

FIG. 13.—Sexradiate spicule from the interior of the body skeleton, very similar in size and form to those which furnished the framework of the secondary network in Fig. 7, Pl. VIII. $\times 50$.

FIG. 14.—Dermal sexradiate spicule. $\times 50$.

FIG. 15.—Dermal sexradiate with distal rays pointed and horizontal rays capitate. $\times 50$.

FIG. 16.—Dermal sexradiate with the distal ray reduced to a capitate termination. $\times 50$. *a*, distal ray on a larger scale. $\times 100$.

FIG. 17.—Sexradiate spicule with very long shaft, probably so disposed in the sponge that the horizontal rays projected some distance beyond the dermal surface. $\times 50$.

FIG. 18.—Curved small form of acerate spicule, capitate at both ends. $\times 50$.

FIG. 19.—Two flesh spicules cemented on to the skeletal fibre.

PLATE VIII.

FIG. 1.—Young fibres of *D. pumiceus*, showing their position relative to the dermal spicules. $\times 100$.

FIG. 2.—Dermal layer of *D. pumiceus*, with the acerate spicules omitted. The young fibres are represented in their relative position beneath it.

FIG. 3.—Young fibre of *D. pumiceus*. $\times 100$.

FIG. 4.—A part of the network from the base of *D. Stutchburyi*. $\times 50$.

FIG. 5.—A single mesh of the basal network filled in with secondary fibres. $\times 50$.

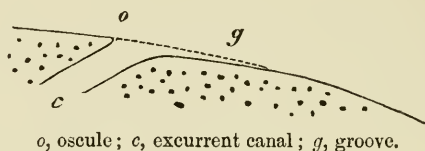
FIG. 6.—Young fibres of *D. pumiceus*. $\times 100$.

FIG. 7.—Secondary reticulation of "darning" fibres from *D. pumiceus*. $\times 50$.

* Stutchbury, 'Proc. Zool. Soc.,' 1841, pt. ix. p. 86; 'Ann. and Mag. Nat. Hist.,' vol. ix. p. 504. Bowerbank, 'Proc. Zool. Soc.,' 1869, p. 77, pl. iii. fig. 1. Carter, 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. xii. p. 363.

upwards and towards the axis of the cup, and frequently prolonged at the sides into a little gutter, as in Fig. 1.

FIG. 1.



o, oscule; *c*, excurrent canal; *g*, groove.

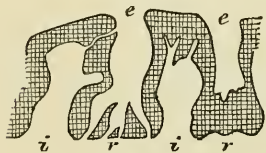
These holes are the mouths of the excurrent canals, which descend into the walls of the sponge, passing especially into the ridges of the outer surface, where, after branching once or oftener, they terminate, either in small round openings on the surface, or by losing themselves in the coarse meshes of the skeleton.

In a similar manner the grooves or gullies of the outer surface are prolonged into tubes which tend towards the inner surface of the cup, ramifying in their course till they open into the excurrent canals, or lose themselves in the large meshes of the skeletal network.

Thus the only connection between the excurrent canals which open on the inside of the cup, and the deep gullies of the exterior, is by means of very minute intervening canals, or through the large meshes of the skeleton.

The ridging and grooving of the exterior, combined with the excavation of the ridges by the excurrent canals, produce a folding of the sponge wall, very similar to that which occurs in the *Ventriculites* and other fossil sponges. In both cases the folding serves to give great strength to the sponge wall, and a large inhalent surface at a great economy of space.

FIG. 2.



Section across the wall of *D. puniceus* ($\frac{2}{3}$ natural size); *rr*, exterior ridges; *ii*, intervening furrows; *ee*, excurrent canals occupying interior of ridge.

The whole arrangement reminds one also of what is seen on a smaller scale in *Halisarca lobularis*, where likewise we have, according to the beautiful sections of F. Eilhard Schultze,* incurrent canals opening externally and branching within into minute canals, which again gather together to form the large excurrent canals that open on the interior of the sponge. Here, however, having a fresh specimen before us complete in all its parts, we can see the ampullaceous sacs on the ultimate ramifications of the incurrent canals, and so understand clearly the mechanism by which water is

* 'Zeitschrift f. wiss. Zool.,' Bd. xxviii. Taf. I. fig. 8; Taf. II. fig. 15; Taf. III. fig. 16.

caused to enter at the inhalent orifices, to pass through the fine canals, and finally to empty itself out of the sponge by the excurrent tubes. But having regard to analogy, one cannot but feel that a similar mechanism once existed in our specimens of *Dactylocalyx*: the minute canals which unite together the ultimate ramifications of the excurrent and incurrent tubes, were the seat of those ampullaceous sacs which by driving the water continually out at one end of the minute canals, caused a continual influx at the other; the single current entering at one inhalent aperture was immensely subdivided to supply a large number of ampullaceous sacs; the many currents leaving those sacs were united together to flow out at an exhalent aperture in a single stream.

Skeleton.—On examining the skeleton of the sponge with the naked eye, one observes a regular network of fibres, the meshes of which may be called “large” meshes to distinguish them from others of which we speak next; similarly, the fibres may be known as “large” fibres.

Under the Microscope the large fibres are found to consist of a network of much finer fibres, and with correspondingly small meshes. These are what are usually understood as the meshes and fibres of the skeleton, so that the terms may be used without any distinctive qualification.

The large meshes may possibly serve in some cases to give passage to the minute ramifications of the water-canals of the sponge.

Dermal layer.—Bowerbank states that he could not find any trace of dermal structure in the half of the type specimen which he examined, but predicts that when a specimen perfect enough to show it is obtained, it will present the characters of the same structure in *Dactylocalyx Prattii* or *D. Masoni*. Unable to believe that the work of cleaning so large a specimen as ours could have been so thoroughly accomplished as to have removed all vestiges of the dermal skeleton, I set to work to find the missing structure, being at the same time well assured that if found it would *not* in a Hexactinellid sponge like *D. pumiceus* present the same characters as in Lithistids such as *D. Prattii* and *D. Masoni*. Nor did I have long to look, for down in a tubule, which completely perforated the sponge, a perfect forest of long acerate spicules was seen, bristling erectly from the surface, and forming, together with a layer of sexradiate spicules, the structure of our search. This tubule, as already remarked completely perforates the wall of the sponge, passing freely from one side to the other; it thus differs from an ordinary excurrent or incurrent canal, and in all probability represents a part of the surface of the edge of the sponge, which became simply enclosed by growth and not incorporated with the body substance. If this is so,

one will have no difficulty in explaining why a dermal layer was found here and nowhere else—not in a single excurrent canal, nor on the sides of the exterior grooves; although, had it at any time existed in these places, it must almost certainly have left some trace of its existence behind. The truth is, the dermal layer must have been confined to the general surface of the sponge, and covered the walls of our tubule, because these were originally a part of the general surface, and only by accident, as it were, came to assume a tubular form. When the specimen was cleaned the dermal layer would readily be removed from exposed surfaces, but would easily escape destruction in this secluded recess. The absence of a dermal layer from the sides of the grooves on the under surface is most noteworthy, and leads one to infer that the dermal layer on the under surface was continued from ridge to ridge, so as to roof over the intervening gullies without in any case dipping into them.

The piece of the sponge exhibiting the dermal layer was carefully cut out and variously mounted for microscopical examination.

If we commence our observation of a transverse section from its outermost face, we shall see first the distal ends of a number of acerate spicules, which when traced inwards for a distance of about a quarter of an inch, are found to enter, normally to its surface, the skeletal network of the sponge, penetrating through its meshes for about the same distance as they project beyond it. Next we find just outside the skeletal network a dermal layer of sexradiate spicules, each with four long horizontal arms extended in the plane of the dermal layer, and with the two remaining arms at right angles to it, the distal one short and frequently aborted, the proximal one descending perpendicularly into the meshes of the skeleton like a little rootlet into the soil. The horizontal arms do not appear to be arranged into a regular square-meshed network.

Beneath the dermal layer we reach the outermost layer of the reticulate skeleton, consisting of framework spicules only just connected together by siliceous cement. The skeletal layer succeeding this is still very young, so that its fibres still retain an open lace-like character, not having yet become filled up with the siliceous deposit, which subsequently in the third or fourth layers renders them solid throughout. In the third and fourth layers then the fibres have assumed the form of solid homogeneous threads which only differ from those of the quite adult skeleton by their greater smoothness and less abundant tuberculation.

Acerate fusiform spicules (Plate VII., Figs. 1, 3, and 18).—These are cylindrical in the middle and taper very gradually towards each end, till they terminate in extremities of remarkable tenuity. The longest complete example measured $\frac{1}{2}$ " in length and 0.0015" in breadth; but these dimensions may be slightly exceeded in some other cases, though one cannot say so definitely, owing to the fact

that the great majority of these spicules are incomplete at one end, and thus incapable of exact measurement. In some cases the end has been apparently broken off, in others it appears to have yielded to some solvent action, either after the death of the sponge, or quite as possibly during its life; for the sponge appears to have been alive when first procured, and the eroded umbones of *Anodon* and *Unio* shells show that such contemporaneous solution is not an unknown phenomenon in the animal kingdom.

The ends of the acerates are roughened by minute spines, which give them a ragged appearance, and their tenuous extremities are pointed. Associated with them are other acerate spicules (Figs. 3 and 18) which differ in a number of minor characters; thus the latter are usually smaller than the former, more often curved, and though sometimes pointed, yet very frequently capitate clavately at one or both ends. The larger acerates are excavated by a well-defined axial canal which, however, never exhibits any trace of a sexradiate cross in any part of its course. I have repeatedly examined a large number of perfect acerate spicules with a view to making sure on this point, and I am able to state therefore with full confidence that none of them show the least signs of a sexradiate character.* Instead of being aborted sexradiate spicules, they are from my point of view the least modified descendants of the simple acerate spicules of which the early ancestral sponge was composed; the sexradiates on the other hand having departed the most widely from the original type.

The coarse meshes where they open at the surface of the sponge, appear as the circular mouths of minute tubes, walled in with the large fibre, and reminding one somewhat of the structure of *Aphrocallistes*. It is into the large fibre surrounding these tubes, but not into that forming their floor, that the acerate spicules are inserted, which thus leave the tubes unencumbered within, but form a beautiful fringe to them externally.

Sexradiate spicules of the dermal layer.—These are remarkably variable in all their characters; the most typical form being that of Fig. 5, Plate VII. This possesses the full complement of six rays, four lying on the surface of the sponge, one descending into its network, and the sixth projecting distally: the distal ray is short, straight, and rounded off at the end, the other five rays are much longer, more or less curved, and attenuated to very fine pointed extremities. All are minutely microspined for the whole or a portion of their length. The greatest breadth of the rays is 0.0003".

In other instances we find the distal ray becoming much shorter, frequently capitate (Fig. 16, Plate VII.), and often disap-

* On referring to Mr. Carter's paper (*loc. cit.*) I find that his examination of the acerate fusiform spicules of *Dactylocalyx subglobosa* led him to the same results.

pearing altogether; the horizontal rays, though sometimes capitate, more frequently extending into long sinuous whip-like filaments (Fig. 14, Plate VII.), which often become branched, and thus give rise to such forms as that of Fig. 8, Plate VII. The curvilinear filaments of different spicules intertwine with one another in the dermal surface, giving it a loosely woven texture, like a single layer of cotton-wool filaments: in some cases they touch without uniting, in others they are soldered together at the point of contact.

The branched rays of Fig. 8 cannot be explained by supposing secondary siliceous fibres to have been independently developed in the dermal sarcode, and subsequently to have become united with the spicular rays; these branched rays can only be regarded as a further development of such undulating forms as that of Fig. 12.

Another form of sexradiate is shown in Fig. 18: in this the proximal ray has become excessively long, the horizontal arms remaining comparatively short; Figs. 2 and 4 are similar, but in the latter, one horizontal ray is bent backwards in an elongate S-like curve, and all its rays are capitate, except the proximal one, which is sharply pointed. In Fig. 18 one of the horizontal arms is suppressed, and in Fig. 2 the distal ray; the number of rays suppressed in different spicules is very variable, sometimes both proximal and distal rays disappear, and only the horizontal arms remain forming a simple cross. The microspining of the spicules on the other hand is very constant, but the mode of termination just the opposite, one, two, or three rays, or any number up to six sometimes becoming capitate, the proximal ray, however, usually remaining pointed.

Some of the sexradiate spicules, those for instance with very long proximal rays (Fig. 18) appear to accompany the bundles of acerates which project beyond the dermal surface, their four horizontal arms not being given off in the dermis, but at some distance outside it, after the manner of anchoring spicules.

One cannot but feel some curiosity as to the function of these various spicules, though without actual observation of the habits of the living sponge it seems idle to speculate upon them. The dermal spicules, however, evidently serve to support the dermal membrane of the sponge; the long acerates have probably, as Bowerbank would maintain, a "defensive" action, and it certainly seems just possible that both they and the projecting sexradiates, especially the latter, may serve to capture and secure any minute worms or other animals which in wandering over the sponge should come in contact with their points. Nutritious material would be freed from such animals at every puncture on becoming wounded, and when subsequently decomposition set in, swarms of Bacteria and other organisms would result, and a vast quantity of edible material so be set free to be conveyed by the inhalent currents into

the interior of the sponge. A similar function might perhaps be assigned to the avicularia of the Polyzoa which hold fast for a long while any little victim which may have been caught between their beaks.

First layer of reticulate skeleton.—Notwithstanding a close search was made for them, no instances of framework spicules existing in a free state could be found; they could be seen in the very first stages of cementation, but not earlier: certainly the dermal spicules are very distinct, and never become involved in the skeletal network, unless by rare exception; the acerate spicules likewise, though occasionally involved, as a general rule remain free. In the first stage of cementation we find two or three or more rays of the framework spicules (Plate VIII., Figs. 1, 3, and 6) attached to the rest of the network, from which the spicule seems to have budded forth, the remaining rays projecting freely and usually outwards towards the exterior of the sponge; these free rays are always more or less clavately capitate, and always microspined, although they appear to have already become invested by a thin layer of the ubiquitous siliceous cement. Some of these rays are very persistent, retaining their freedom for a long while, especially those which point directly towards the exterior of the sponge. Near the centre of the attached spicule fine siliceous filaments cross from one adjacent ray to another, subtending the angle formed by them, so that when all six rays have been so connected together, a hollow lantern joint results, which, when regularly developed (Plate VII., Fig. 11), closely resembles the octahedral nodes of *Mylinsia Grayi* or of a *Ventriculite*. Usually, however, its form is much less symmetrical than this, owing chiefly to irregularities in the form and distribution of the framework spicules themselves, but partly also to the irregular way in which the connecting fibres join them together.

The rays of each spicule are bent in all directions, and the entire spicules are scattered in great confusion, some lying one way, and some another. The rays of adjacent spicules thus exhibit no definite arrangement one with another; sometimes the end of one touches the middle of another ray, and where they touch they unite; sometimes two rays lie parallel to each other at a slight distance apart, then transverse bridges of silica cross from one to the other, and unite them into a fenestrated fibre; frequently one ray traverses the centre of another spicule, and thus multiplies the number of fibres radiating from the resulting node of the finished network.

As the deposition of silica continues, the attached ends of the spicular rays become covered up and disappear, the fenestra of the open fibres are filled in, and solid more or less cylindrical fibres result; so, too, the open lantern of the nodes is in time obliterated,

and the whole skeleton, losing all traces of its original composition, exhibits simply a reticulation of solid fibres radiating from equally solid simple knots. The young fibres are at first smooth, but very early, almost as soon as they become optically simple, they become tubercled, and with age the tubercles increase in number and size.

Secondary rete.—After the formation of the adult network, changes appear to take place in the distribution of the canals of the water-system, by which some of the large meshes become no longer needed as water-channels, and so are gradually filled up by a secondary network, of what might appropriately be called “darning” fibres, from the way in which they seem to mend up the gaps in the aged skeleton. In one case I found this secondary network in a very early stage (Plate VIII., Fig. 7), its component spicules having only just become soldered together by silica, and differing considerably in appearance from the budlike spicules, or pullulating fibres of Bowerbank, which likewise unite into a secondary network. As the secondary fibres thicken with the continual deposit of silica over them, they produce a network of a very different appearance to that of the principal skeleton, its fibres are more rodlike, often sharply and conically spined, less thickened at the nodes, and sometimes more rectangularly arranged. Contrast, for example, Fig. 7, which is somewhat like the network of a *Cypellia* (Zittel), or the spined fibre of Fig. 6 with the excellent figure of the ordinary skeletal reticulation given in Bowerbank’s Memoir, plate i., *loc. cit.*

Other spicules besides sexradiates which become involved in the siliceous fibre.—That the large acerate spicules may sometimes contribute to the skeletal network has already been mentioned, but I have never before met with an instance in which a flesh-spicule became so involved. Such a case, however, is shown in Fig. 19, Plate VII., where two flesh-spicules are seen closely attached to the surface of a skeletal fibre: in one the process of envelopment has not gone so far as in the other, so that, although the angles between its rays have been to a great extent filled up, yet its characteristic form is more nearly retained, and the rays attached to the fibre are still so far unenveloped as to allow the light to shine through between them; the other, on the contrary, has become converted into a mere globular tubercle, with the yet uncovered ends of its rays projecting as little spines.

In commenting on the foregoing descriptions, one may first point out the analogy which exists between the rude folding of the walls in *Dactylocalyx* and the more perfect folding in such extinct forms as *Cœloptychium* and the *Ventriculites*. The resemblance between *Cœloptychium* and *Dactylocalyx* appears to be especially marked; in both we have radial ridges and gullies, of about the same size in each; in both the ridges are bifurcated, anastomosed laterally, and marked on the exterior with rounded openings leading

into interior tubes. In *Cœloptychium*, however, all these features possess a regularity which is not to be found in *dactylocalyx*; the ridges in the former sponge are more uniform in size, straighter in direction, and more regular in their bifurcation and anastomosis; the circular openings upon them are also of very uniform diameter, and are arranged at equal distances apart in regular rows.

Notwithstanding these differences of detail, however, an obvious general resemblance exists between the two sponges when their lower surfaces are alone compared, while, as regards general external form, one must allow that *Dactylocalyx*, especially the variety *D. Stutchburyi*, represents in a striking manner some of the widely infundibuliform specimens of *Cœloptychium*. In other respects more essential differences are to be found.

The character of the nodes in the newly formed network of *Dactylocalyx* may be also alluded to again, since they are always hollow and reticulate to begin with, and not solid throughout as in the later stages of growth; moreover, as already stated, the young node often exhibits an octahedral arrangement in its reticulation, which clearly resembles that of the true hollow-jointed Hexactinellids, and thus passes through a stage which in the latter sponges has become persistent. From this it would appear that in the ancestral form of Vitreo-hexactinellid the nodes were all characterized by a lantern-like arrangement, and that while in some of its descendants the subsequent deposition of silica at the node took place chiefly along the octahedral fibres, and thus gave the Ventriculite knot, in others it followed no definite direction, but simply filling up the interspaces, produced the solid node of such forms as *Dactylocalyx*.

Dactylocalyx pumiceus, var. *Stutchburyi* (Plates V. and VI.)—This form will not require any lengthy description, since it agrees in all important characters with the preceding, and it is only in details of quite trifling value that any difference exists. The general form is that of a vase or flower-basket, but with a much less expanded brim than the type of *D. pumiceus*; its walls are also a trifle thicker than the latter, and the ridges and grooves on its inferior surface are deeper, narrower, and straighter. The elliptical margin of the cup measures 1 foot $1\frac{1}{4}$ inch along the major axis, and 10 inches along the minor axis. It is 5 inches in height. The surface of attachment, i. e. the base of the pedicel is covered with a layer of denser tissue than occurs elsewhere in the sponge. The fibres of this layer are usually flattened, smooth, seldom tuberculated, and only at intervals connected with the interior body network. Between such points of connection the layer often remains single in thickness, and being flattened and smooth on both faces, presents the appearance of a cribriform plate (Plate VIII., Fig. 4). Sometimes the rounded holes of this plate are filled in with a delicate

tracery of secondary fibres, when it closely resembles the (Plate VIII., Fig. 5) dermal layer of some fossil sponges. The chief fibres of the basal layer are formed on a framework of sexradiate spicules, which may be revealed as casts by boiling in caustic potash; the secondary fibres appear to originate in threads of silicifying sarcode, which have crossed from one side of a mesh to the other. These secondary fibres must not be confused with the secondary fibres of the body skeleton; the latter spin across large meshes, and are moulded on spicules, the former across meshes of the small fibre, and are not deposited on spicules.

The oscules of the inner surface of the sponge exhibit a tendency to elongate into channel-like grooves, following a radiate direction with respect to the axis of the vase, and somewhat resembling the grooves of the under surface, though of much smaller dimensions, never exceeding, for instance, an inch and a half in length.

The openings of the upper surface are so abundantly spined by prolongations of the body skeleton as to give to the whole interior of the cup a rough spinose appearance, which is in marked contrast to the smooth, even surface of the unspined fibres of the under side. In Fig. 2, Plate V., the spines produce round the oscules the appearance of a denticulated margin. They may be obtained readily for microscopic examination by breaking off with a fine-pointed pair of scissors, and catching them as they fall on a spread-out sheet of glazed black paper. Three such spines are represented in Figs. 2, 3, 4, Plate VI. They consist of a prolongation of the skeletal network into a generally hollow reticulate and pyramidal spine, which might be very appropriately named a "lantern-spine" from its rough resemblance to the lanterns used in architecture. The longitudinal fibres of the spine usually become much thicker with age than the rest, as may be seen in Fig. 2, where they have entirely obscured the transverse fibres from sight, if transverse fibres ever existed. The subsequent deposit of silica has, indeed, in many cases so thickened the fibres and modified the original reticulate form as to lead one to doubt whether they were ever modelled on a sexradiate form. A little boiling in caustic potash, however, will soon reveal the imbedded sexradiate spicules, which possess here just the same characters as in other parts of the network. The deposit of silica over them is so thick, however, as to overwhelm them altogether in some cases, as, for instance, in the lateral secondary spine (Fig. 3) projecting from a principal one, which is not represented in the figure, but the direction of which is indicated by an arrow: in this instance we have a conical spine moulded over a sexradiate spicule, and the same thing has taken place in the pointed end of a spine shown at Fig. 4. The spines frequently support one or more long acerate spicules, which pass through and project beyond them like a lance in rest. Now and then these

acerates become involved in siliceous deposit, and form an integral part of the spine.

Similar spines were detected on the upper surface of the type specimen of *D. pumiceus*, but they are much less abundant in it than in its variety *D. Stutchburyi*.

FIG. 3.

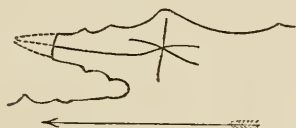


FIG. 4.



Fig. 3, Lateral spine. Fig. 4, Terminal point of a "lantern" spine $\times 145$. The dotted lines indicate the ends, which have been broken off.

At the bottom of the vasiform cup of *D. Stutchburyi*, at one side, is a cylindrical tube $\frac{1}{2}$ an inch in diameter, obliquely perforating the wall from side to side, and in this, as in a similar tube in *D. pumiceus*, remains of the dermal spicular layer were discovered. A fine collection of the spicules was cut out, but, being blown away by a current of air, was lost, and no subsequent searching succeeded in recovering it. Enough was obtained from what remained, however, to show that the characters of its spicules were the same as those of the dermal layer already described, the projecting acerates and dermal sexradiates both being present; a larger number of dermal spicules, however, were found with distal and proximal rays aborted, the four rays remaining being spread out horizontally in the dermal surface.

By holding the sponge upside down, and smartly tapping the bottom of the pedicel, a large number of long acerates were shaken out; they were generally incomplete at one end, and in a single instance one was observed with the extremity rounded off, thus presenting us with an acute variety of this kind of spicule.

The relations of the excurrent and incurrent canals could be prettily illustrated by holding the sponge up to the light; looking then into the shaded interior of the cup, one saw illuminated patches opposite the incurrent openings, and these patches always fell on the continuous network of the sponge, never coinciding with an excurrent aperture; when the position of the sponge was reversed, the excurrent apertures similarly cast illuminated images on the surface of the outer ridges, but never coincided with incurrent openings, thus demonstrating the absence of completely perforating canals. Of course the perforating tube previously mentioned is an exception, but then that does not belong to the water-system of the sponge.

XI.—*The Aperture Question.* By J. MAYALL, jun., F.R.M.S.

(Read 8th January, 1879.)

THE question of the existence of apertures, by means of the immersion system, greater than correspond to the maximum possible for dry lenses, has received such powerful support in the affirmative from Zeiss's new oil lenses, that it is almost superfluous to call attention to the position of the discussion. But as the chief exponent of the adverse view still maintains that it is an "undecided question," I will briefly state the most obvious points that occur to me.

It had been asserted by Mr. Wenham that 82° in the body of the front lens is the *limit* beyond which no object-glass can collect image-forming rays. I quote a passage from his writings to show that he has clearly pledged himself that this limit obtains equally in dry and immersion lenses on balsamed objects:—

" . . . the immersion lens . . . had no property for collecting from a balsam-mounted object a greater number of rays, but that the limit is the same as in the dry lens."

Many passages might be cited conveying the same view.

This is equivalent to asserting the existence of a *natural limit*, depending on twice the critical angle (from glass to air), and, consequently, the impossibility of any objective collecting to a focus a pencil of rays from a radiant in balsam of greater aperture than that which in this medium corresponds to 180° in air. It was to this assertion as regards the *limit* in relation to immersion lenses that exception was taken.

On this question Professor Stokes was urged by me to give a demonstration, and I think it must be admitted that the assertion is thereby refuted as a question of theory. Mr. Wenham admits the validity of the reasoning, but insists that in practical constructions the *limit* of 82° obtains.

Mr. Wenham's views had been brought to definite issue by his published report of his measurement of the aperture of Tolles's $\frac{1}{8}$ immersion lens (owned by Mr. Crisp). The constructor had alleged the lens to be made on a formula by which an aperture was obtained, measured in the body of the front lens (or in a suitably adjusted semi-cylinder—for it is demonstrable that the results are equivalent), 16° beyond the maximum possible for dry lenses,—that is to say, Mr. Tolles claimed for it an aperture in glass of 98° .

Mr. Wenham reported the aperture to be 68° in glass.

The point of interest to me was to prove whether the aperture exceeded 82° .

Passing over some discussions that took place in correspondence, which were not communications to the Society, I may state that I felt under an obligation to place before the Society the evidence I

could adduce on behalf of the original claim that the aperture of the $\frac{1}{8}$ exceeded 82° ,—the evidence being Professor Keith's computation of the angle, and the actual measurement by means of Professor Abbe's apertometer which I exhibited at the meeting in June last.

Mr. Wenham's answer to the computation amounts to this:—Because the computed angle is based on the assumption that the radiant is in balsam, therefore it falls to the ground.

Now the question with regard to this lens never was to know if the aperture in the body of the front lens could exceed 82° when adjusted so as to have a front-focus in air. No one had ever alleged such a proposition. All admit that 82° (in glass) is the *limit* for dry lenses, and, of course, all lenses may be regarded as dry if there be a stratum of air between the object and the front lens. The question was, What is the aperture when the lens is adjusted to have a front-focus in balsam? To this Professor Keith's computation answers by tracing the paths of different rays from the back-focus to the front-focus in balsam, and the result (110°) proves that the formula is designed to produce an aperture greater than corresponds to 180° in air,—which was to be demonstrated. Mr. Wenham's criticism upon it is thus seen to be irrelevant.

When the radiant is in balsam, and in immersion contact with the front lens, the critical angle (between glass and air) is no longer a factor in the elements, and can have nothing to do with the aperture, because the rays do not go into air until their emergence at the second surface of the front lens, which is not parallel to the plane front, but deeply curved. With a dry lens, the effective angle of rays from the object in balsam is limited *at the object itself* to 82° —no greater pencil can emerge from the cover-glass. With an immersion lens this limit varies with the immersion medium; with water it is about 126° , with oil the limit depends on the construction of the lens, and may possibly be carried as near to 180° in glass as the present dry lenses approach their limit of 82° . This is a matter for the ingenuity of the opticians.

With regard to the elements furnished for the computation, it is extremely improbable that Mr. Tolles arrived at the precise numerical data by mere guessing; but even in that case, as formerly remarked by Professor Keith, "the force of the result would have been the same."

In confutation of Mr. Wenham's position in the aperture question, we have had two formulæ for immersions placed before us, by which an aperture in the body of the front lens exceeding the *limit* of dry objectives has been traced to the radiant in balsam: the one relating to the $\frac{1}{16}$ (three system) by Tolles in the collection of the United States Army Medical Museum; the other, to the $\frac{1}{8}$ (four system) referred to above; in each of which Professor Keith has

computed the aperture to be about 110° . We have Professor Stokes's authority for the validity of these computations.

As to practical measurements: we have the testimony and report of Dr. Woodward, Professor S. Newcomb, and Professor Keith on behalf of a four system $\frac{1}{2}$ by Tolles. We have Dr. Woodward's report of the measurement of the $\frac{1}{16}$ to which the earlier computation referred; and I exhibited the measurement of the $\frac{1}{8}$ before the Society, with Professor Abbe's apertometer. In all these cases apertures were recorded beyond the limit contended for by Mr. Wenham.

I felt bound to exhibit the actual measurement of the $\frac{1}{8}$ to which the newer computation referred; at the same time I was provided with twelve other immersion lenses by Tolles, Powell and Lealand, and Zeiss, all of which would have afforded similar proof.

I do not attempt to follow Mr. Wenham in his various suggestions for angle measuring. I have found the results obtained with Professor Abbe's apertometer confirmed by a modification of Professor Robinson's plan of measuring (adapted for immersion lenses), and therefore, until Mr. Wenham can show some material error likely to arise from the proper use of the apertometer, I shall continue to regard it as a convenient and reliable appliance.

With regard to the supposed effect of the "outer oblique rays extending to the margin of the field," Professor Keith's computations refer only to the central pencil—have nothing to do with any appreciable diameter of field. If apertures be measured by means of a small pencil of sunlight from the eye-piece, the diameter of the field at the front focus is almost inappreciable, and therefore no question can possibly arise concerning "outer oblique rays": this has been done in many cases to test the accuracy of the apertometer method.

NOTES AND MEMORANDA.

Cells, and their Vital Phenomena.—Professor W. Flemming, of Kiel, has published * a detailed account of his extensive researches on the structure of nuclei, and their behaviour during the process of cell-division. The observations were made chiefly on cells from various parts of the body of the larval *Salamandra*; these were examined in the living state, and also after treatment with chromic acid, followed by absolute alcohol, staining with safranin, and clarifying, after a second treatment with absolute alcohol, with oil of cloves. Hæmatoxylin staining of chromic and picric acid preparations was also employed.

According to Flemming, the quiescent nucleus consists of—

1. An investing membrane.
2. An intranuclear network consisting of an extensive system of ramified filaments exhibiting at intervals thickenings or pseudo-nucleoli.†

3. The true nucleoli.

4. A pale ground-substance filling up the remaining space, and devoid of visible structure in the living state, but assuming a granular or fibrillar appearance by the action of reagents.

In the process of cell-division the nucleus passes through the following phases:—

1. The somewhat coarse intranuclear network is converted into a fine-meshed coil, presenting a basket-like appearance.

2. The meshes of the coil become coarser and at the same time looser.

3. The coil assumes a wreath-like form, a space being left in the centre of the nucleus free from filaments.

4. The filaments again advance to the centre, but separate into loops peripherally so as to give the whole nucleus a star-like form.

5. The individual rays of this star undergo longitudinal fission along their whole length, producing

6. Another star-form, distinguished from the first by the extreme fineness of its rays.

7. The star-form disappears, its filaments becoming collected into a plate-like body, situated equatorially across the centre of the cell.

The foregoing are the changes undergone by the mother-nucleus preparatory to division; the following are the stages of the daughter-nuclei. It will be seen that they correspond with those of the mother-nucleus, but occur in an inverse order.

8. The equatorial plate assumes a sort of barrel-shape; a plane across the equator of the barrel is free from filaments, and marks the plane of division of the nucleus; from this plane the filaments radiate, converging slightly, in two directions, or towards the original bounding planes of the equatorial plate.

9. Probably, though this is by no means certain, the filaments

* 'Archiv f. Mikr. Anat.,' vol. xvi. (1878) p. 302.

† This word is employed in a different sense by Van Beneden.

now fuse together in pairs, producing a similar figure to the last, but coarser.

10. The two daughter-nuclei (the two halves of the barrel-form) separate from one another, and each assumes a star-shape.

11. The rays of each star unite and form loops, the wreath-form being the result.

12. The filaments of the wreath become thicker and more closely meshed.

13. As the process of division approaches completion, the coils become finer, and the basket-form is produced.

14. Finally, the ordinary intranucleolar network is produced, marking the completion of the division process and the entrance of the nuclei into a state of quiescence.

Picro-carminé for Cell-nuclei.—In the Report published last August of the Proceedings of the International Congress of Botanists, held at Amsterdam in 1877, is a paper by M. Treub, who drew attention to the use of picro-carminé as a reagent for this purpose. His first step is to kill the cells by absolute alcohol, according to the directions of Strasburger. After making some sections of tissues which had remained in the liquid, the preparations are placed in a 1 per cent. solution of picro-carminé, for a time varying from four to twenty hours; they are then shaken in distilled water in order to dissolve the picric acid, and are placed in a mixture of glycerine and distilled water, which is gradually replaced by pure glycerine containing 1 per cent. of formic acid. After this treatment the nuclei almost always assume a fine red colour, whilst the protoplasm remains entirely uncoloured, which enables the slightest changes which take place in the nuclei to be at once distinguished.*

Influence of the different Colours of the Spectrum on Animals and Plants.—1. *Animals.*—Observations on the influence of the different coloured rays of solar light upon the nutrition of plants have been more numerous than those on the development of animals. M. Beclard in 1858 experimented with eggs of *Musca carnaria* under different coloured glasses, and found that the eggs developed very unequally, those of the violet and blue rays developing most rapidly, and in the green least.

M. E. Yung† has for three years experimented at the University of Geneva with the eggs of *Rana temporaria*, *R. esculenta*, *Salmo trutta*, and *Lymnea stagnalis*.

The eggs were placed directly after fecundation in vessels which were plunged in solutions coloured respectively violet, blue, green, red, and white, one being also placed in the dark.

The general results were as follows:—

(1) The different coloured rays of solar light act in a very different manner on the development of the eggs of the above animals.

(2) Violet light quickens the development in a very remarkable

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 129.

† 'Comptes Rendus,' vol. lxxxvii. (1878) p. 998.

manner. Blue comes next, and then yellow and white, which are nearly equal in their effects.

(3) Darkness does not prevent development, but, contrary to the results of MM. Higginbottom and MacDonnell, does retard it.

(4) Red and green light seem to be hurtful, as the complete development of the eggs placed in these colours could not be obtained.

(5) Tadpoles subjected to the same conditions and deprived of food died sensibly sooner in violet and blue light than in the others—they consumed their food store more rapidly.

(6) The mortality seemed to be greater in coloured light than in white light. Nevertheless, as the results have not always agreed on this point, it would be premature to consider this as positively proved.

2. *Plants*.—In 1869 M. P. Bert showed * that certain plants placed under green glass soon died. He thought the explanation was to be found in the green colour of the leaves—to allow none but green light to reach them was to give them what they rejected as useless. Reflecting that these leaves, under a great thickness, appeared red, he thought the plants would die also behind red glass, but was surprised to see that they did not.

This apparent contradiction led him to undertake a further examination.†

If green and red glasses are examined through the spectroscope by diffused sunlight, we see that the red glass intercepts the yellow and all the most refrangible part of the spectrum, only allowing the orange and the red to pass; while the green glass intercepts about three-quarters of the red, starting from the left hand.

The first maintains life, the second kills, and therefore the necessary part of the spectrum is found in this red which the green glass absorbs.

To further determine whether this property is to be attributed to the whole intercepted extent of the red, he compared a solution of chlorophyll, with the green glass, and saw that the part of the red which it absorbed, extended, from left to right, as far as the first absorption band characteristic of chlorophyll (included between the lines B and C), and concluded that it was the part of the spectrum corresponding to this band, which, absorbed by the leaf, was indispensable to its life.

Further experimenting, he found that plants, lighted by a good diffused light, and surrounded with vessels with parallel glass sides containing an alcoholic solution of chlorophyll very frequently renewed, immediately ceased growing, and very soon died: this solution, which was very weak and in a very thin layer, intercepted hardly any but the characteristic parts of the red.

The indispensable part of white light is consequently there, where, moreover, M. Timiriazeff ‡ has recently found the maximum of re-

* 'Comptes Rendus,' 14th February, 1870.

† Ibid., vol. lxxxvii. (1878) p. 695.

‡ Ibid. Sitting of 28th May, 1877.

duction of carbonic acid. If we prevent it from reaching the leaf, the plant being reduced to consume the reserves previously accumulated, becomes exhausted, and finally dies.

But though this part of the spectrum is necessary to plant life, it cannot be said that it is sufficient. Behind red glass, plants live a very long time, no doubt, but they become elongated to excess, and slender, with their leaves narrow and pale-coloured, because they are deprived of the violet blue rays.

Thus every part of the solar spectrum contains portions which play an active rôle in the life of plants. In the most refrangible rays are found those which govern the destruction of tension. In the red are those which determine the tension of the tissues and produce the phenomena of reduction, which are the foundation of vegetable life. Their total, properly proportioned in white light, is necessary for the vital harmony.

It is very probable that these parts utilizable by plants are accurately marked by the different absorption bands of chlorophyll; but to be quite sure, we should have to experiment with luminous spectra, intercepting the different parts by screens, and recomposing by means of lenses. The bad weather last summer did not allow M. Bert to operate with the solar spectrum, and he accordingly made arrangements for using a strong electric light, the results of which have not yet been published.

Colonel Woodward on the Oil-Immersion Objectives and the Apertometer.—Colonel Woodward has examined the $\frac{1}{8}$ and $\frac{1}{12}$ objectives made by Mr. Zeiss, on what Professor Abbe terms the "Stephenson homogeneous immersion system," and thus reports upon them:—

"My first trial by lamplight immediately convinced me of the excellent quality of the $\frac{1}{8}$ and of the surpassing excellence of the $\frac{1}{12}$. On testing them by monochromatic sunlight, using a microscope body with draw-tube, by which I could get ten inches precisely with a range of a couple of inches either way, I speedily satisfied myself that the performance of the $\frac{1}{8}$ fully equalled, while the $\frac{1}{12}$ excelled, the best of the large collection of immersion objectives belonging to the Museum. For photographic purposes the objectives gave similarly satisfactory results.

I find that the saving of time in using these oil-immersion objectives on histological preparations mounted in balsam, and in all similar work, is very great. With water and even glycerine immersion objectives every conscientious worker loses much time with the cover adjustment, and this is entirely economized, while the results, instead of being inferior, are superior to any obtainable with the best objectives made on any other principle."

Colonel Woodward's measurement (by a method of his own) of the aperture of the objectives gave 115° interior angle for the $\frac{1}{8}$ and 114° for the $\frac{1}{12}$. By the apertometer he made the angle of each a little more than 1.25 (numerical aperture). In regard to the scale of the apertometer, Colonel Woodward considers that it has, among other inconveniences, this, that its divisions are too far apart for any very

accurate readings, and that it is to be regretted that it was not arranged so as to read the angle in crown glass (i.e. the interior angle) to degrees. It would have been far more convenient for ordinary use, and just as easy to compute water, air, or glycerine angles from the crown-glass angles as from the ordinary scale.

Professor Abbe, writing to Mr. Stephenson, says that "for the observation of bacteria the oil-immersion lenses are becoming more and more appreciated by German microscopists. There is no doubt your plan which enabled us to get rid of the refractions outside the objective and at the front face, will be considered an important step in the improvement of objectives. In addition to the increase of aperture, the homogeneity of the medium from the object to the first spherical surface turns out to be a great advantage in respect to fine definitions."

Diffraction Experiments with *Pleurosigma angulatum*.—Colonel Woodward also says, in reference to these experiments,* that though by lamplight he readily observed all the phenomena as described by Professor Abbe, yet on trying by sunlight he obtained different results. The fine longitudinal lines produced by diffraction were distinctly visible on all parts of all the frustules and entirely without limitation to the adherent parts as required by Professor Abbe's theoretical explanation. In the photographs of a frustule in which the adherent parts are comparatively small (laid before the Society at the February meeting), that obtained with the $\frac{1}{8}$ showed the diffraction lines, after the introduction of the diaphragm, on all parts of the frustule without regard to the line of adhesion, while with the one taken with the $\frac{1}{12}$, the same was true for one side of the frustule, the other side being slightly out of focus. A similar diffraction picture of the right side of the frustule could have been obtained, but then the left would have been out of focus, a result of the form of the frustule. In neither case are the diffraction lines limited to the adherent parts. When, however, the illumination was obtained by lamplight the diffraction lines were rigidly limited to the adherent parts.

On these remarks Professor Abbe writes as follows:—

"The fact observed by Colonel Woodward that the longitudinal lines on *Angulatum* appear throughout the whole frustule in observing or photographing with direct sunlight, is not astonishing to me after having considered the distance of those lines more accurately than I had done before. The photographs give this distance (measured in the middle part of *both* photographs) = 0.335μ ($\mu = 0.001 \text{ mm.} = 1 \text{ micro-millimetre}$), the wave-length of $D = 0.589 \mu$, $F = 0.46 \mu$. Therefore the distance *exceeds* the half wave-length even of D , and the lines are, theoretically, within the range of the numerical aperture 1.0 for oblique light. It will thus be a matter of intensity of illumination only, whether they will be visible or not visible through a film of air, and it is quite natural that on the non-adhering parts of a valve they are not visible with lamplight, but yet are visible by direct sunlight."

* This Journal, vol. i. p. 53.

Brain of Invertebrates.—M. Dietl has two important papers on this subject in the 'Proceedings of the Vienna Academy,'* in the first of which he describes the brains of *Eledone*, *Sepiola*, and *Tethys*, and in the second that of *Astacus* and *Squilla*. The former is illustrated by nine plates, the second by one plate. The papers consist entirely of detailed descriptions of the brains in question, and do not readily admit of abstracting. We are therefore reluctantly obliged to confine ourselves to the record of their publication.

Poison Apparatus and Anal Glands of Ants.—Dr. August Forel gives in the 'Zeitsch. für wiss. Zoologie' † an exhaustive account, with two plates, of these structures. He first gives an account of the sting in the *Formicidae*, stating that in his Section α of that family the organ is quite rudimentary, while in Section β , although very small and delicate, it has all the structure of the sting of *Myrmicidae* and *Poneridae*.

Of the poison apparatus, consisting of gland and receptacle, there are two types, one found in Section α of *Formicidae*, the other in Section β of that family and in all other ants. From this circumstance, as well as from the structure of the sting, Forel proposes to divide *Formicidae* into two sub-families, *Camponotidae* (Section α), and *Dolichoderidae* (Section β). The types are distinguished as (1) poison-bladder with pad (*Polster*); and (2) poison-bladder with knob (*Knopf*).

(1.) In the first type the poison-bladder is elongated and widened and provided with a duct of but little less diameter than itself. Its walls consist of a tunica intima bounding its cavity, then of a layer of protoplasm with scattered nuclei, representing an epithelium, and finally of an outer tunica propria containing muscular fibres. On its dorsal side, between the intima and propria, is a large flattened cushion-like body, the *pad*, consisting of a greatly coiled, branched or unbranched chitinous tube, the coils being separated from one another by a layer of nucleated protoplasm. Although the pad itself is not more than 2 mm. long, the tube may attain a length of 20 mm. At one end the tube opens into the bladder, with the intima of which the edges of the aperture are continuous. At the other end, situated posteriorly or under the duct of the bladder, it is connected with a pair of glandular filaments, lying external to and on the dorsal side of the bladder. These filaments are the free portion of the poison-gland, the coiled tube of the pad with its protoplasm constituting its intra-vesicular portion. The free gland-cæca consist of a layer of epithelial cells, covered by a tunica propria continuous with that of the bladder, and lined by an intima, bounding the lumen, and sending off very fine lateral tubes to the individual gland-cells.

(2.) In the second type the poison-bladder is small and nearly globular, and its duct is a fine tube with walls thrown into transverse folds. The free portions of the poison-gland are shorter and thicker than in the first type; the united portion, answering to the

* 'Sitzungsberichte der (Wiener) k. Akad. der Wiss.,' vol. lxxvii. (1878), 1st Abth. p. 481.

† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), (1878), p. 28.

pad of *Camponotidæ*, pierces the tunica propria of the bladder, losing its own tunica propria, and, pushing the intima before it, hangs free in the cavity, either as a twisted tube with a knob at the end—whence the name of this type of apparatus—or as a mere knob: in either case the whole intra-vesicular portion of the gland is invested by the invaginated intima of the bladder, which takes the place of the tunica propria. At the extremity of the knob is the aperture by which the gland opens into the bladder, and at which the in-turned intima of the latter becomes continuous with the true intima of the gland. The protoplasm of the gland exhibits no cell contours, but only nuclei imbedded in granular protoplasm, the latter being pierced by the fine chitinous offshoots of the intima of the gland. The knob is made of an accumulation of cells, also with chitinous tubules.

In connection with both types of poison apparatus are found accessory glands (*Nebendrüsen*) lying towards the ventral side of the poison-bladder, and answering to the oil-gland of bees and other Hymenoptera. They are unpaired glands, opening by a duct immediately below the opening of the poison-bladder, and may be either simple or bilobed. The wall consists of five layers, an intima bounding the large cavity, a layer of polygonal epithelial cells, one of scattered nuclei, a tunica propria, and a network of fine muscular fibres. The secretion is oily and of a yellowish colour.

The anal glands and anal bladders are stated to have been hitherto overlooked in ants; they are formed by an infolding of the wall of the cloaca between the anus and the pygidium or last outwardly visible tergum. The bladders are two large ovoidal sacs closely applied to one another in the middle line, and uniting posteriorly into a small ampulla from which proceeds the short duct; their walls consist of an intima, a delicate protoplasmic matrix with scattered nuclei, a tunica propria, and a network of muscles. The glands are also two in number, and each is closely applied to the outer wall of the corresponding bladder, into which its duct opens by a large funnel-shaped aperture. The gland-cells are large and spherical, and very easily separated from one another; each contains a large nucleus with many nucleoli, and is supplied with a special tracheal branch. The duct of the gland gives off fine lateral offshoots, one of which proceeds to each gland-cell: on reaching the cell its protoplasmic outer layer becomes continuous with the cell-membrane, while its chitinous intima pierces the protoplasm of the cell, increasing in diameter, and describes several curves, probably ending blindly. Forel ascribes the peculiar smell of some ants (e.g. *Tapinoma*) to the secretion of these anal glands: he has seen it ejected on an enemy.

Parthenogenesis in Bees.—In continuation of the discussion on this subject (see p. 88), M. M. Giard* considers that the true explanation of the observation of M. Pérez is to be found in a supplementary means of nature to assure the reproduction of the immense posterity of the social Hymenoptera. Besides the normal queens, which lay continually,

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 755.

there are fertile workers, among which copulation is not observable, and is perhaps even impossible for various reasons. They are well proved and frequent amongst the wasps and *Polistes*; to them is attributed, among the drones, the considerable number of males which are observed late in the autumn. They exist among certain species of ants, notably *Formica sanguinea*. Fertile workers have been recognized for a long time among bees; but until recently these fertile workers, as they only laid male eggs, like the drone-bearing queens, conformably to the Dzierzon theory, were thought to be very rare and accidental. They are, on the contrary, frequent, and coexist with the queen in a great number of hives. As in M. Pérez's hive there was a mixture of yellow, black, and hybrid workers, the fertility of certain workers of the two last sorts is sufficient to explain the mixture. An exclusive laying of black drones has even been found in the case of an analogous hive.* More than this, a yellow Italian mother, fecundated, not by a black male, but by a yellow Italian male of her own race, being given, by artificial swarming, to an orphan colony of black bees, not only numerous yellow but also black drones appeared after a certain time. These latter, M. Giard thinks, could only come from fertile black workers; "for, in order to find the black ancestors of M. Sanson, it would be necessary to throw back the atavism into the night of ages, farther perhaps than the bees of Virgil." To decide this question irrefutably, we must employ the method of elimination, and suitably separate the layings of the queen and of the fertile workers.

Hermaphroditism in Perlidæ.—Dr. Alexander Brandt, of St. Petersburg, describes† an interesting case of hermaphroditism in certain of these orthopterous insects (*Perla bipunctata*, &c.), in which he found undoubted ovaries in connection with the testes of male larvæ, both male and female glandular follicles being developed as out-pushings of one and the same excretory duct.

Employment of Mixtures of Chromic and Osmic Acids for Histological Purposes.—Dr. Max Flesch recommends‡ this mixture in the following proportions:—

Osmic acid	..	..	..	..	..	0·10
Chromic acid	..	..	..	..	..	0·25
Distilled water	..	..	..	..	..	100·00

It answers particularly well for the auditory organs of smaller animals, many of the details of structure of the cochlea coming out with quite diagrammatic clearness. The hairs of the hair-cells are, however, mostly lost. It also answers well for examining the growth of bone in the epiphyses of small animals, and for general views of retina, conjunctiva, cornea, and the eyelids; in these latter many details suffer, especially the bacillary layer of the retina.

The objects for examination are placed fresh in the fluid, and kept there from twenty-four to thirty-six hours. There is no need to keep

* See the journal 'Apiculture,' August, 1878.

† 'Zool. Anzeiger,' vol. i. (1878).

‡ 'Archiv f. Mikr. Anat.,' vol. xvi. (1878).

them in the dark, as the osmic acid in conjunction with chromic does not undergo such rapid changes by light as when alone. In the case of cochlea, young bones, &c., a further treatment with 0·25 to 0·5 per cent. solution of chromic acid may be necessary for complete decalcification. The object is then washed and placed in spirit, and the sections may then either be examined in glycerine, or treated successively with absolute alcohol and turpentine, and then mounted in Canada balsam.

The great advantages of this fluid are its rapid hardening properties, and the fact that no further staining is necessary, the osmic acid imparting sufficient colour to the cells, even when mounted in balsam.*

Microscopical Research under Difficulties.—Professor Ray Lankester, writing to 'Nature,'† says that the following short preface to a very valuable account of the stages of development from the egg of one of the centipedes (*Geophilus*), no member of which group had been studied previously to this account, gives so convincing a picture of the enthusiasm for investigation which may animate the modern naturalist, that he extracts it for the encouragement of the "craft."

Elias Metschnikoff has during the past fifteen years worked more assiduously with the Microscope at the observation of the minute details of embryology than any other student. To him we are indebted for our first accurate knowledge of this subject in the case of many important animal forms, e. g. sponges, various jelly-fishes, marine worms, the scorpion, and the book-scorpions, various insects, crustaceans, starfishes, and ascidians. One result has been the injury of his eye-sight. In his memoir on *Geophilus*,‡ he says:—"After having for many years sought in vain for material suited for the investigation of the embryology of the centipedes, I chanced to obtain a quantity of the eggs of *Geophilus*. My find, however, took place under such circumstances, and these interfered so much with my investigation, that I feel justified in describing them more minutely. For some considerable time I had been afflicted with a chronic affection of the eyes, and consequently commenced in the spring of the present year a journey to our south-eastern steppes in order to turn my attention to anthropological studies. Instead of taking with me, as in previous years, all the apparatus necessary for microscopical research, I took this time on my journey only anthropological measuring instruments. When, then, I was in the neighbourhood of Manytsch, nearly in the heart of the Kalmuk steppes, and was visiting a small forest plantation, I discovered quite unexpectedly a number of eggs of *Geophilus* which had been deposited under the bark of a rotten tree-stem where the females were watching over them. I gathered up the precious material, and having packed it carefully in two bottles, set off with all

* A mixture of chromic and osmic acids for embryological purposes was recommended by Dr. A. Milnes Marshall in 'Quart. Journ. Micr. Sci.,' N. S., vol. xviii. (1878).

† 'Nature,' vol. xix. (1879) p. 342.

‡ 'Zeitschrift f. wiss. Zool.' (1875).

speed to Astrachan, in order there to set about the microscopic investigation of the eggs. But when, after four days' travelling, I arrived in a Russian village, Jandiki, near the shore of the Caspian Sea, and inspected my two bottles, I found in them only a couple of dead, opaque eggs, all the others having entirely disappeared. Fortunately I succeeded in Jandiki, where there is also a small plantation, in obtaining fresh material of the same kind, and this I brought in good condition to Astrachan, making the journey by steamboat. In the town of Astrachan I was able to borrow a Hartnack's Microscope from a medical man practising there, and on a second journey took it with me to Jandiki. In this way I was enabled to make out the chief features of the developmental history of *Geophilus* by the use of my less seriously affected left eye. At the same time, in spite of the very favourable character of the *Geophilus* eggs for microscopic research, I could not bring my work to the desired degree of completeness."

Determination and pluck, Professor Lankester adds, have their scope in embryology!

Degeneration of the Visual Organs in Arachnida.—Among the group of pseudo-scorpions, some, such as *Chelifer*, have well-developed eyes, while others, such as *Chernes*, are usually said to be quite devoid of visual organs. The interesting discovery has, however, been made by Anton Stecker, of Prague,* that certain individuals of the latter genus possess eyes, although in a rudimentary condition. In specimens of *C. cimicoides*, Stecker observed on the cephalo-thoracic shield, in the position of the eyes of *Chelifer*, clear, somewhat transparent spots, the chitin forming them being devoid of the granulations covering the rest of the shield. These structures have quite the appearance of corneas, but their visual nature is put beyond question by the remarkable fact that each is supplied by a large and well-developed optic nerve, proceeding from an optic ganglion in connection with the brain. The characteristic anthropod end-apparatus—the layer of crystalline rods—was, however, wholly absent.

About 30 to 35 per cent. of the specimens of *Chernes cimicoides* examined possessed these eye-spots; in the remaining 65 to 70 per cent. they are absent, as well as the optic nerves; while there was only one, or even no, recognizable rudiment of an optic ganglion. It was also made out that the offspring of parents, both of which had eyes, were themselves provided with these organs; but that if either the father or the mother were blind, the young were blind too, having, at most, a feeble indication of optic lobes.

As the author remarks, we have here a most instructive case of the gradual atrophy of an organ by disease, owing to the influence of changed conditions. There can be little doubt that the ancestors of *Chernes* possessed well-developed eyes; the disappearance of the crystalline cones and of the characteristic structure of the cornea seems to have been the first step in the retrogressive process, the optic nerve and ganglion remaining in a fairly well-developed state after the true per-

* 'Morphologisches Jahrbuch,' vol. iv. (1878) p. 279.

ipient apparatus had gone. It is an interesting circumstance that the optic nerve of *Chernes* seems to have, in some degree, taken on the function of a nerve of common sensation, since many of its fibres are distributed to the layer of connective tissue underlying the hypodermis.

In one individual of the same species a curious malformation occurred, there being a single eye in the middle line of the cephalothorax, instead of the usual pair. The organ in question had a slightly convex cornea, divided into hexagonal areas; beneath this was a layer of crystalline rods, and a strongly developed layer of brown pigment. This thoroughly well-formed visual organ is supplied by both optic nerves, which, after leaving the brain, ran forwards parallel with one another, to the layer of crystalline rods.

Two cases of abnormal organs of sight were also met with in *Chelifer ixoides*. In one of these the eye on one side was perfectly normal, but on the other, while the nerves and bacillary layers were well developed, the cornea formed a mere speck, like the eye-spots of *Chernes*. In the second instance, both eyes were developed, but were so small as to be hardly visible; the crystalline rods and pigment, at the same time, were much reduced.

Ascent and Circulation of the Sap.—The course and the causes of the ascent and circulation of the sap in plants are attracting much attention just now among French physiologists, and the results should be carefully studied in connection with the recent researches of M. Boussingault and the Rev. G. Henslow as to the power of leaves to absorb water in the fluid or gaseous state. A recent number of the botanical series of the 'Annales des Sciences Naturelles'* contains three articles bearing more or less directly on this subject. In the first of these, "On the Influence of the Temperature of the Soil on the Absorption of Water by the Roots," M. J. Vesque arrives at the following general conclusions:—

1st. In no case can absorption be practically separated from transpiration, in a plant under normal conditions. As soon as the absorption exceeds the transpiration, the former diminishes, and is probably regulated by the latter; when the transpiration is suppressed, the absorption gradually lessens, and finally ceases. The reason of this phenomenon doubtless lies in the manner of behaviour of the air within the plant. The transpiration ceasing to make a vacuum, there comes a time when the atmospheric pressure, *plus* the pressure from the roots, is incapable of overcoming the tension of the internal air and the resistance of filtration.

2nd. When the temperature of the soil is rapidly raised, absorption diminishes in consequence of the increase of the pressure of the air contained in the wood. For the same reason, absorption increases when the temperature of the soil is rapidly lowered.

3rd. Each temperature of the soil being considered as a constant, the absorption increases with the temperature; except perhaps in high temperatures, where the question has not yet been completely worked out.

* 'Ann. des Sci. Nat.' (Bot.), 3rd ser., vol. vi. (1878) p. 169.

4th. The temperature of the soil has much less influence on absorption than that of the air (by the intermediation of transpiration) under ordinary conditions of moisture. For a much stronger reason, it is of but little consequence for a plant growing in the open air to be exposed to the burning rays of the sun.

The same author follows this paper by one "On the direct Comparison of Absorption with Transpiration."* The principal conclusion to which a long and careful series of experiments has led him, is that the amount of absorption does not bear any direct proportion to that of transpiration; and his general results are summed up as follows:—

1. Of all the theories proposed up to the present to explain the motion of the water in the plant, that of Boehm (referred to hereafter) is most in harmony with observed facts.

2. Although transpiration is the most powerful cause of absorption, these two functions are not necessarily proportional.

3. Absorption is equal (in general terms) to transpiration when the plant grows in average and very slightly varying conditions; for example, in diffused light and in moderately moist air.

4. When a plant removed from these average conditions is exposed to dry air, transpiration is much stronger than absorption. It cannot possibly attain so high a figure as transpiration; the plant withers, and it is exposed to an irreparable disturbance, which consists perhaps in the abnormal destruction of the vacuum existing in the plant.

5. When a plant is removed from these average conditions of growth, and exposed to air saturated with moisture, the absorption, obeying the already existing vacuum, is stronger than the transpiration; but in proportion as the vacuum fills up, the absorption decreases, and finally ceases if the transpiration has also ceased (state of repletion).

6. When a plant lacks water, the suction produced by transpiration is not lost; it accumulates, and comes into operation as soon as the roots come in contact with water. An absorption much more energetic than the transpiration is then observed; but this continues to diminish in proportion as the existing vacuum fills, to be finally regulated by the intensity of transpiration.

The paper by M. Boehm, "On the Causes of the Ascent of Sap," † is a very valuable one:—

Even now, he says, the majority of physiologists consider the movement of the water excited by transpiration in the turgescient cells of the leaves to be a purely osmotic phenomenon. Owing to the continuous production of organic matter in the assimilating cells, the osmotic tension would always have such an intensity that the water coming from the neighbouring cells would replace the loss caused by transpiration. This view is, however, as he believes, erroneous, for the following reasons:—

1st. The movement of water produced by osmose is extremely slow.

* 'Ann. des Sci. Nat.' (Bot.), 3rd ser., vol. vi. (1878) p. 201.

† Ibid., p. 223.

2nd. The cells which directly transpire—those of the epidermis—are generally destitute of chlorophyll; they do not assimilate, and cannot produce matters capable of causing an osmotic diffusion. It is probable that they contain nothing but water, which cannot be concentrated by evaporation.

3rd. If the evaporated water is replaced by the action of osmose, the leaves of the plant which assimilate in moist air would be covered with the water which is given off, and the intercellular spaces would also become filled with water. This has, however, never been observed.

4th. In a green plant exposed in a damp and dark place, the differences of osmotic tension in the cells of the leaves would gradually be effaced by the consumption of the osmotic substances, or by their departure into the stem. The leaves remain fresh when the plant is transported into dry air without permitting access of light.

5th. If the movement of water in the leaves were produced by the differences in density of the contents of the cells, it would act in the same manner in parenchymatous wood, a supposition which will not be maintained.

If the movement of water in the leaves is not due to osmose, this is still more the case with wood, the cells of which in general only contain air when transpiration is very active. Some authorities believed till quite recently that the force of absorption by the roots may have the power of forcing up water even to the topmost boughs of trees. But a considerable number of facts are in opposition to this theory. In a great number of cases it is impossible to prove the existence of any such *vis a tergo*.

M. Boehm, in conclusion, says that, in the parenchymatous tissues filled with sap, the movement of water excited by transpiration is a function of the elasticity of the cell-walls and of the atmospheric pressure, and in cells with rigid walls the elasticity of the wall is replaced by that of the air enclosed in the cells. The presence of a certain quantity of air in the cells of the wood which conduct the sap, far from being a hindrance to the ascent of the sap, is on the contrary an indispensable agent in the production of this movement.

Some have maintained that the ligneous cells of plants in full transpiration contain nothing but air, and that, as no water is seen in them, therefore there is none. But the author pointed out, as much as fifteen years ago, when all micrographers believed the contrary, that the fibres of Coniferae are closed, and not open. The position of the membrane of the bordered pits evidently depends on the differences of tension in the two adjoining cells, and corresponds to the direction of the current of the sap. The constant presence of a certain quantity of water in the ligneous conducting cells is an undoubted fact.

The movement of the water excited in plants by transpiration is a phenomenon of filtration dependent on the differences of pressure in adjoining cells.

Growth of the Root of Phanerogams.—M. Ch. Flahault has made an elaborate anatomical study of the structure of the apex of

the root in all the important groups of Phanerogams.* The results of his investigations show that the characters of the apex of the root cannot serve for the appreciation of the reciprocal relations of the families, and that the views of M. Treub on the taxinomic importance of these characters are not well founded. Plants most closely allied often differ very much in the structure of the apex of their roots, and on the other hand, plants belonging to widely separated families have common radicular characters.

The structure of the vegetative summit can in fact only serve as regards classification to establish positively whether a plant is a monocotyledon or a dicotyledon.

Removal of Air from Microscopic Specimens.—Much difficulty has been experienced by the working microscopist in removing air from his specimens, especially with wood sections, and various methods have been adopted with greater or less success. One method has been to soak the specimens, after they have been cut, in different fluids for some length of time, such as turpentine, oil of cloves, and the like; these, however, give very unsatisfactory results, sections of wood having lain in oil of cloves for over three years without the air-bubbles having been all removed. Recourse has also been had ineffectually to the air-pump, and microscopists have been at their wits' end to discover some process by which their object can be perfectly and satisfactorily accomplished.

It is claimed† for Dr. Johnson, of Providence, R.I. (U.S.), that he has discovered an effective method. The apparatus he employs is of very simple construction, being a digester, or a common dentist's vulcanizer, the means—steam. The specimens to be thus treated, especially those of wood, are prepared in the usual way, and made ready for mounting. They are next placed in a small vessel of any material which will resist a certain amount of heat. Dr. Johnson uses a small glass phial in his experiments; this is filled up with water after all the specimens, as many as it can conveniently hold, are placed within. A cork can be used, but a slit must be cut in it to allow the escape of air and the admission of steam and hot water. A little water is now poured into the vulcanizer, the bottle of objects placed within, and the lid of the machine screwed air-tight. The whole is then heated to a temperature of about 300° Fahr. for a few minutes. This temperature is sufficient for all practical purposes; a higher degree of heat is unnecessary, or a longer time to remain at the given temperature needless.

When sufficiently cooled the phial is removed, the water drained from the bottle, and alcohol substituted. The specimens are now ready for mounting, or can be bottled and set away indefinitely for use.

This constitutes the whole process; by it the specimens are *absolutely free* from air. Perfect satisfaction is guaranteed; and in every case we are absolutely sure of the results, provided, of course, that the proper care has been taken.

* 'Ann. Sci. Nat.' (Bot.), 6th ser., vol. vi. (1878).

† 'American Naturalist,' vol. xiii. (1879) p. 57.

The *modus operandi* seems to be that the steam penetrates the pores of the wood or other substances, and forces out the air, whose place it takes. The air is then absorbed by or dissolved in the surrounding medium. The woody fibres are not destroyed by the hot and compressed steam, except the soft tissues, as one would at first sight suppose. They are entirely uninjured, and their purposes for microscopic study remain as good as by any other process. Tender specimens in every case must be tenderly treated. This mode of procedure has been followed by several microscopists in America for two or three years, and all the specimens so treated have been remarked for their beauty and excellence.

Immersion Illuminators.—Mr. Wenham thinks that too much is said in favour of the prism which he described in 1856 * (intended to be attached to the under surface of the slide by oil of cloves), by some who take it up as a recent discovery. He at once abandoned it in favour of a lens nearly hemispherical, of about $\frac{2}{10}$ radius, which is much more convenient and effective for all purposes, and less costly. This lens is then attached to the under side of the slide by the oil, in the same way as the prism, or it may be set in a thin plate of brass to be slid under the slide and centred under a low power if necessary; or otherwise mounted in a sub-stage fitting of such a form as not to interfere with the passage of the most oblique rays that can be sent into it sideways, which are by this appliance transmitted straight to the object. When used with a dry objective, the object is seen on a dark field, the rays being reflected from the top of the cover, which acts as a Lieberkuhn.†

In a letter to ourselves Mr. Wenham says that he finds no illuminator equals it, for he can *immediately* bring out *Amphipleura* without the least trouble, even when mounted in balsam; a feat that has sometimes before cost him half an hour's work.

Phosphorescence of the Flesh of Lobsters.—The following view of the cause of this phosphorescence is put forward by Messrs. Bancel and Husson.‡ The first alteration observed in the flesh of marine animals is the formation of a gelatinous substance, and it is then that phosphorescence appears.

Examined under the Microscope, two kinds of germs are seen; on the surface, cells which without doubt produce this kind of mucous fermentation; in the mucus, infinitely small bacteria.

The former, which are of a reddish yellow, are aerobic, and appear to act as plants, that is, that during the day they decompose the carbonic acid of the air, fixing the carbon and setting the oxygen free, which remains in solution in the liquid.

If this liquid contains an anaerobic germ, its development is arrested—it is anaesthetized. But in the night the cell disengages carbonic acid, the germ lives, and the consequences are the destruction of the

* 'Quart. Journ. Mic. Sci.,' vol. ii. (1856) p. 2; and see this Journal, vol. i. (1878) p. 309.

† 'English Mechanic,' vol. xxviii. (1879) p. 501.

‡ 'Comptes Rendus,' vol. lxxxviii. (1879) p. 191.

surrounding matters, with condensation of oxygen on one hand, and on the other the production of carburetted and phosphuretted hydrogen when the medium contains phosphates.

When the oxidizing power of the ferments is considered, it is seen that these hydrogenous products are burnt in proportion as they are formed, and thus the phosphorescence is explained.

All the facts observed prove that the phosphorescence of the lobster is due to an analogous fermentation. This is confirmed by the fact that the ferment of the phosphorescence is destroyed by the putrid ferment in the same way as the vibriions of putrefaction stifle the bacteria of anthrax.

Species of Marine Crustacea in Lake Erie.—At the meeting of the Buffalo Microscopical Club, of the 10th November last, Professor D. S. Kellicott communicated a note on the discovery of a species of marine crustacea in the waters of Lake Erie. He had captured a species of *Mysis* in the hydrant water, thus confirming the previous detection of these creatures in the waters of the great lakes by Stimpson and Hoy.*

It is not stated whether the species is *Mysis relicta*, which is well known to inhabit the fresh-water lakes of Norway and Sweden as well as America.

Professor Kellicott also stated that the body of the *Mysis* was covered with a marine Protozoa, *Acineta tuberosa*, a matter interesting in connection with the fact recently mentioned by Professor H. L. Smith,† of the occurrence of marine forms of diatoms in the waters of the lakes.

Gigantic Isopod of the Deep Sea.—Professor Alexander Agassiz has sent to M. A. Milne-Edwards the crustacea collected by him in December, 1877, from dredgings in the Gulf Stream between Florida and Cuba. Amongst them was an Isopod obtained at 955 fathoms, which was remarkable not only by its relatively enormous dimensions, 9 inches \times 4 inches, but by the special arrangement of its respiratory apparatus, which is very different from that of all other known crustacea. M. Milne-Edwards proposes to call it *Bathynomus giganteus*.‡

It would seem that the respiratory apparatus of an ordinary Isopod is insufficient for the physiological wants of *Bathynomus*, and that it requires special apparatus of much greater functional power. The false abdominal feet which ordinarily constitute the branchial apparatus, only form in *Bathynomus* a kind of opercular system under which are found the true branchiæ. These taken separately resemble small branching tufts or plumes growing out of stems which divide more and more and form long hair-like filaments. When examined with a magnifying glass it is seen that they form a certain number of distinct branches more or less developed, and that each of these branches arises from or grows out of a tubular

* 'Amer. Jour. of Microscopy,' vol. iii. (1878) p. 284.

† See this Journal, vol. i. p. 368.

‡ 'Comptes Rendus,' vol. lxxxviii. (1879) p. 21.

peduncle with membranous and flexible walls which soon bifurcate to form other branches; these are resolved into a number of elongated filaments nearly alike, but without regularity, and having the appearance of a spindle with delicate walls.

If some coloured liquid is injected into the sinus at the base of the branchial feet, the whole of this system may be easily filled and the liquid followed not only in the branchial tuft, but also in an irregular network sunk in the thick part of one of the leaflets of the false abdominal feet and comparable to the entire branchial apparatus of the ordinary Isopods. A marginal vessel serves to collect the blood and to send it into the branchio-cardiac trunk.

In all the other Isopods the false abdominal feet are very simple, and wherever they are complex to meet the requirements of a more active circulation, it is by the rudimentary foldings of the posterior plate of these members.

In *Ione* and *Képon* * branched appendages are found on the sides of the body, but there are fundamental differences between these and *Bathynomus*, not only in the position of the plumes, but in their structure also.

Though inhabiting great depths, the eyes are well developed, each having about 4000 facets, and in place of being at the top of the head they occupy its inferior face, and are placed beneath the frontal margin on each side of the base of the antennæ.

Bathynomus is separated by important characters from all other Isopods, and justifies its being placed in a new family of "branchiferous Cymothoadians."

Limicolous Cladocera.—In the introductory part of a paper on these Entomostraca,† Dr. W. Kurz gives an account of the main difference between these mud-dwellers and their free-swimming congeners. The distinctive characters of the former are due, firstly, to the increased pressure of water to which they are subjected; secondly, to the thickness of the mud in which they live; and thirdly, to the altered relation of the gases absorbed in the water at a considerable depth below the surface. The first two of these conditions give rise to the thick integument and clumsy form which characterize the limicolous species. The carapace is strengthened either by the thickening of its cuticle or by the remarkable circumstance that, at the moult, the old armour is not cast off, but remains superposed on the newer and larger parts beneath, like an old-fashioned "spencer" over a coat; three or four carapaces of progressively increasing size may thus be seen in a single individual. The antennæ of the limicolous forms are comparatively very short and stout, and the setæ on them are not feathered. The whole body has a rounded form, and the brood-pouch is extended laterally, not vertically as in the free forms. As a rule they swim with the dorsal surface downwards. The power of swimming seems to be in inverse ratio to the size of the post-abdomen and the complexity of

* Spelt *Képon* by A. Milne-Edwards; *Képone* by Adam White; and *Cépon* by Duvernoy.

† 'Zeitsch. f. wiss. Zoologie,' vol. xxx. Suppl. (1878) p. 392.

its armature of spines and setæ. The chitin of the limbs and other parts covered by the carapace is very thin, so that the respiratory surface is much increased. It is doubtful whether this is due to the paucity of oxygen in the medium inhabited, or the thickness of the carapace and its consequent unfitness for respiratory purposes, or because of the exertion of burrowing through the mud which these animals have to undergo. The compound eyes are always much reduced, or may even be entirely absent. At the same time the simple eyes are increased in size and importance, being sometimes larger than the compound eyes, and sometimes having the whole visual function assigned to them.

The remainder of the paper is taken up with a description of the typical genus *Ilyocryptus*, and of its various species, the chief points in the anatomy of which are illustrated in the plate which accompanies the paper.

New Cryptogamic Journals.—In addition to 'Brébissonia,' a monthly journal devoted to Algology,* which first appeared in July last year, and the bi-monthly 'Revue Bryologique,' which has existed for five years, we now have a new journal, published every three weeks, for Fungi—the 'Revue Mycologique,' edited by M. C. Roumeguère, the first number of which appeared in January last. The contents of this number will be found noted in "Bibliography."

Unit of Micrometry.—We stated at p. 353 of vol. i. that the resolution of the Indianapolis Congress, which recommended the $\frac{1}{100}$ of a millimetre as the unit of micrometry, was approved by the New York Microscopical Society. At a subsequent meeting, however, some of the members had the subject reconsidered, and the former approval was unanimously rescinded. The editor of the 'American Journal of Microscopy,' to whose views reference was also made at p. 353, says the action of the Congress "is now generally considered to have been too positive and definite, for the simple reason that the subject had not been sufficiently discussed or considered by the members present."

The Microscopical Section of the Troy Scientific Association have appointed a committee to confer with other microscopical Societies on the subject of micrometry, and that committee, by a circular issued in December last, suggest the appointment of a larger committee (on which each Society should be represented by a member), whose duty it shall be to investigate the questions mentioned below, confer with the Societies and with persons known to be experts in this department, and report to the American Society of Microscopists, at their next meeting at Buffalo in August. They state that their Society, whilst earnestly desiring the success in some practicable form of the movement suggested by the Congress, believe that much further preparation will be required to enable the American Society to take definite action, and that, to prevent the movement being a failure, it must be entered upon after mature deliberation and full consultation, and in such manner as to secure the general and cordial assent of

* See this Journal, vol. i. (1878) p. 368.

those who are prominently interested in and qualified to judge of the subject. To secure the preliminary investigation and the moral power necessary to this end, if the end is now attainable at all, they invite the co-operation of the Societies as above mentioned, as well as of microscopists generally.

The questions are as follows:—

(1) Is it expedient at present to adopt a standard for micrometry?

(2) If so, should the English or the metric system be employed?

(3) What unit within the system selected is most eligible?

(4) What steps should be taken to obtain a suitable standard measure of this unit?

(5) How can this standard micrometer be best preserved, and made useful to all parties concerned? *

M. G. Huberson, the editor of 'Brébissonia,' thinks † it "is sad that a second micrometric unit should be established in the New World, when the Old World has already for a number of years adopted the $\frac{1}{10000}$ of a millimetre as the unit of micrometric measurements, on the proposition of Professor Suringar, of Leyden (Holland)."

The Tomopteridæ.—The interesting pelagic Chaetopods ("errant" Annelides) which constitute the two genera of this family, have been investigated by Gruber, Leukart, Carpenter, Claparède, and others. Recently, Dr. Franz Vejdovsky, of Prague, has taken up the subject, and contributes a paper to Siebold and Kolliker's 'Zeitschrift,' ‡ illustrated by two excellent plates, and dealing chiefly with certain points in the anatomy of *T. vitrina*.

1. *Nervous System and Sense Organs.*—There is a great amount of discrepancy between the accounts of the central nervous system given by different authors. Busch described a brain consisting of two united ganglia, but saw no ventral nerve-cord; the latter was described by Gruber and by Kefertein, but Leukart and Pagenstecher saw only the brain, and Carpenter and Claparède described in *T. onisciformis* a single fibre passing from the latter along the dorsal side of the animal, but denied the existence of the ventral cord and circumoesophageal commissures.

The nervous system of *T. vitrina* was investigated by Vejdovsky, both in the fresh condition and after treatment with osmic acid, alcohol, and picro-carmin. The brain is of a somewhat triangular shape, the base being in front; from its anterior angles the tentacular nerves are given off, while from its ventral surface proceed the circumoesophageal commissures, which curve round the gullet, some of their fibres uniting with one another in the middle ventral line, while others are continued backwards into the ventral nerve-cords, a small interval being left between the latter. In this interval lies a longitudinal row of nerve-cells, while another row is situated immediately external to each of the ventral cords, so that there are three distinct rows of nerve-

* 'Amer. Jour. of Microscopy,' vol. iii. (1878) p. 279.

† 'Brébissonia,' vol. i. (1878) p. 80.

‡ 'Zeitsch. f. wiss. Zoologie,' vol. xxxi. (1878).

cells—one median and two lateral—separated from one another by the fibrous cords. The space between the two latter, which is wider above than below, is probably the remains of the primitive medullary groove. The lateral rows of nerve-cells, although continuous, present accumulations at intervals, corresponding to ganglia. These spots are marked in the recent state by patches of violet pigment, from which prolongations are continued along the nerves.

The eyes are seated directly upon the brain; the lens is single, not double as in other species; the pigment is black. The structures situated just in front of the brain, and described as vesicles by Carpenter and Claparède, were only seen in one specimen, and are in reality pits, possibly of a sensory nature, although no nerve-supply was made out to them.

One of the most important points in the paper is the interpretation given by Vejdovsky to the anomalous "rosette-like organs" of the parapodia. One of these is situated near the edge of the fin-like expansion of both notopodium and neuropodium; it is of a bright yellow colour, and consists of five to seven prismatic bodies arranged in a circle. This is all that can be seen in the fresh state; but after treatment with osmic acid, alcohol, and picro-carmin, the yellow rosette is stained black, and the prisms of which it is composed become very distinct, and are seen to be surrounded by a fine homogeneous investing membrane; abutting against their upper ends is seen a convex, highly refracting lens, while at the base of the rosette is a clear roundish area, surrounded by a zone of nerve-cells, from which fibres are given off to the pigment of the prisms. The "rosette-like organ" is thus proved to be a parapodial eye: the animal possesses two of these visual organs to each parapodium, over and above the already known cephalic eyes.

2. *Sexual Products and Seminal Ducts*.—The ova begin as groups of cells formed on the living membrane of the prolongations of the body-cavity into the parapodia. These groups become detached, and float freely in the perivisceral fluid; of the cells of which they are composed, one develops at the expense of its sister-cells, and becomes an ovum. No external aperture for the escape of the eggs was observed.

The seminal cells have a similar origin: the ripe spermatozoa escape from the body by the segmental tubes. These organs consist of a tubular ciliated internal portion, opening into the perivisceral cavity by a funnel-shaped aperture with a rosette-like ciliated border, and of a dilated external portion opening on the surface of the body by a rounded aperture. The dilated half of the tube acts as a vesicula seminalis. In the posterior part of the body the spermatozoa become aggregated into rounded masses (Samenklumpen), devoid of an investing membrane, but mistaken for testes by Carpenter and Claparède.

The paper concludes with a discussion of the various species of *Tomopteris* and *Eschscholtzia*, the two genera of Tomopteridæ.

Abnormal Sexual Organs in the Horse-Leech.—A very curious variation from the ordinary type of generative organs is described by

Dr. G. Asper, of Zurich.* In the horse-leech (*Aulastoma gulo*), as in other *Gnathobdellidae*, the male organs usually consist of nine to twelve testes on each side of the body, opening into a common vas deferens, which is convoluted anteriorly, forming the vesicula seminalis. From each vesicula seminalis the seminal duct is continued into the base of the single, median penis. The ovaries are two in number, one on each side; each is connected with a short oviduct, which joins with its fellow to form a common canal continuous with the muscular vagina.

The peculiarity of the abnormal form consisted in the fact that the duct from each vesicula seminalis led to a separate penis, so that there were two perfectly distinct intromittent organs, one opening on the twentieth, the other on the twenty-fifth segment. A similar bilateral arrangement existed in the female organs. An ovary was found in the twenty-fifth segment, near the corresponding penis, its duct having a common opening with the latter. A similar female apparatus, consisting of ovary and oviduct, occurred in the thirtieth segment of the opposite side.

The Early Development of Equisetaceæ.—Taking Hofmeister's account of the development of the *Equisetaceæ*, it was very difficult to make out the exact relation between the first stages of the embryo in this group, and the corresponding stages in the other vascular Cryptogams. In Mr. Vines's paper "On the Homologies of the Suspensor," † the horse-tails are purposely left out of consideration in the comparison drawn between the embryos of Phanerogams and of the higher Cryptogams. But the difficulty seems to be quite cleared up by Sadebeck's recent paper, ‡ in which the early stages in an *Equisetum arvense* and *E. palustre* are carefully described, and are seen to correspond very exactly with those of, for instance, the fern *Ceratopteris*.

The first septum makes an angle of about 70° with the axis of the archegonium, and divides the oosphere into two cells, an upper, the embryo proper, turned towards the neck of the archegonium, and a lower, the embryophore, the homologue of the suspensor of Phanerogams and of *Selaginella*. Each of these cells is then divided by a septum at right angles to the first, so that four quadrants are produced, the two upper belonging to the embryo, the two lower to the embryophore. Of the former, one becomes the apical cell of the plant, soon assuming the characteristic form of a short three-sided pyramid with convex base; the other becomes the first leaf. The latter, along with the two first segments cut off from the apical cell, forms the first leaf-sheath of the young plant. Of the two lower quadrants, one becomes the "foot," a temporary organ for the absorption of nutriment from the prothallus, the other becomes the first root, an apical cell being formed, from which the base is soon cut off by a tangential septum, producing the root-cap.

A new Rotifer—Anuræa longispina.—Professor D. S. Kellicott, of Buffalo, U.S., has found § a rotifer in Niagara water at that place

* 'Zool. Anzeiger,' vol. i. (1878) p. 297.

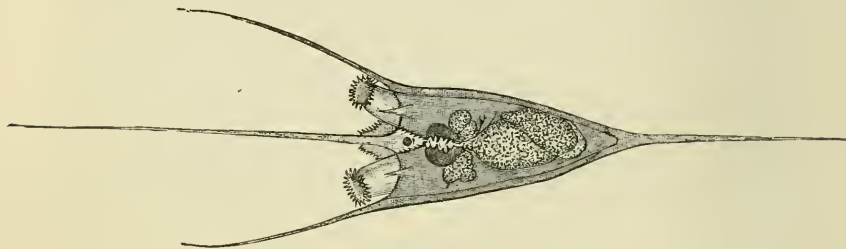
† 'Quart. Journ. of Micr. Sci.,' N. S., vol. xviii. (1878).

‡ 'Jahrbücher f. wiss. Botauik,' vol. xi. (1878).

§ 'American Journal of Microscopy,' vol. iv. (1879) p. 20.

having very long formidable-looking setæ, to which he proposes to give the name of *Anuræa longispina*, the long-spined Anuræa.

We have shown the description and drawing to Dr. Hudson, who considers the claim of "new" to be properly made, though the drawing is probably a little "free" as regards the internal organs. Not having seen the animal ourselves, we are, of course, unable to do more than reproduce the woodcut in facsimile.



The description of the rotifer is as follows:—Lorica ovate-cuneate, smooth on both the dorsal and ventral surfaces; it has seven frontal and one terminal spine; the frontal spine situate on the middle of the upper margin is about twice as long as the carapace; seen from above it is straight, from side arched; those at the angles are equal in length to the carapace, curved outwards and downwards; there is a short one on either side of the long central one, also two short ones on the margin of the ventral surface; they seem to form ribs, nearly to the middle, designed to strengthen the ventral plate of the lorica, so that it opens and shuts the front by a hinge-like motion at the middle, similar to the lower shell of a Box turtle; the terminal spine is somewhat longer than the lorica, straight seen from above, cynosuric in side view. The three long frontal spines when highly magnified, always appear rough, like the surface of the carapace of *Ceratium longicorne*; the terminal one is always smooth.

The buccal funnel situated in the lower middle part of the face between the trochal lobes is deep and ciliated; on its upper border is a projecting conical lip well ciliated; these cilia seem to be able to close over the mouth to aid in the retention of the prey. The mallei and incus of the mastax are easily made out, and are of the typical form. Œsophagus short, digestive cavity clearly divided into a capacious gastric expansion, and an intestine, or cloaca. The two glands, one on either side of the œsophagus, are distinct, round in one aspect, oblong in another. Eye large, round, red. Egg attached. Length, including the spines, $\frac{1}{40}$ of an inch; length of lorica, $\frac{1}{170}$ of an inch. The male unknown.

Professor Kellicott seems to have found them at all times, though more abundant in autumn and winter. Like others of the family, the female carries under the posterior part of the body "her unreasonably large ovum, like an old-fashioned hen's egg." The case is so transparent, that it affords a good example for the study of its structure.

When under the compressorium its horns hold it in place so that it may be studied while alive with high powers.

Trichinæ.—At a soirée given at Chicago to the State Microscopical Society of Illinois, Dr. W. T. Belfield and Mr. H. F. Atwood showed some pieces of muscle from rats fed with *Trichinæ*, on a warm stage, with the worms in a living condition moving about. "It is 'claimed,'" says the 'American Quarterly Microscopical Journal,' "that this is the first time that living *Trichinæ* have been shown in 'public. The value of such exhibitions in arousing a public interest "in scientific studies must be very great, and we trust they will become "more frequent." *

Trichina-phobia at Berlin.—For some time past the well-founded fear of trichina has led to a microscopic examination of much of the meat, especially pork, sold in Berlin. Recently the occurrence of this pest there has been more frequent, and Dr. Luetdge, the Director of the Microscopic Aquarium, has consented to give a course of instruction in this branch of microscopy, which began on February 17. The course, with practical exercises, occupies five hours, and is open to ladies and gentlemen at the fee of 5s. † The catalogues of opticians at Berlin have long contained as a speciality, "Achromatic Microscopes specially constructed for *Trichinæ* researches," and accompanied by "an illustrated description of *Trichina spiralis* and its development."

Organogenic Researches on the Capsule of Mosses and on the Embryo of some Polypodiaceæ.—M. Kienitz-Gerloff ‡ has examined *Phasum cuspidatum*, *Ceratodon purpureus*, *Fumaria hygrometrica*, *Barbula muralis*, *Atricum undulatum*, &c. His results are as follows:—

1st. The development of the sporogonium of all the Bryaceæ, and even of *Andræa*, begins, after the preliminary transversal partition of the oogonium, by the formation of an apical cell; the latter originates from the segmentation produced by two septa oblique in opposite directions.

2nd. The growth of the summit of the organ ceases rather early, as soon as the apical cell is divided by periclinic § or longitudinal septa.

3rd. Each segment is divided by a radial septum into two quadrants, inside which the first longitudinal partitions form an *endothecium* which is separated from the surrounding tissue or amphithecium; the *endothecium* furnishes the columella and the mother-cells of the spores; the *perithecium* furnishes the wall of the sporangium.

4th. The layer of mother-cells originates on the interior of the *endothecium* by either primary or secondary partitions; in the former case the internal sporiferous sac is formed after the layer of mother-cells; in the latter, at the same time. The cells of the columella may be transformed into a fertile tissue producing spores.

5th and 6th. The first longitudinal partition which takes place in the *amphithecium* separates from it the external sporiferous sac, whose

* 'Amer. Quart. Mic. Journ.,' vol. i. (1879) p. 167.

† 'Nature,' vol. xix. (1879).

‡ 'Botanische Zeitung,' 1878, Nos. 3 and 4.

§ That is, convex in the same direction as the periphery.

disappearance then creates between the sporiferous internal sac and the wall of the sporangium the internal cavity of the urn, crossed by filaments which come from the wall.

7th. The peristome belongs by its origin to the amphithecium. The primary number of its teeth is four, corresponding to the four quadrants of the transversal section, in which the radial septa alternate regularly with the periclinic septa.

8th. In the interior of the seta and the vaginula, the cellular partitions follow in the beginning the same laws as the segments which are formed later on; the later partitions become irregular, and trace inside the tissue the first outline of the central cord.

As to the ferns, the author has studied *Pteris serrulata*, an *Aspidium*, *Adiantum cuneatum*, and *Gymnogramma chrysophylla*. He differs from Hofmeister in that he considers, in the quadrant resulting from the division of the oospore, the suspensor of the embryo as coming from one of the cells near to the base of the archegonium, and the root as emanating from one of the cells near to the orifice.* He supposes, moreover, that notwithstanding the fundamental differences which characterize its development, the embryo of the ferns corresponds to that of the mosses. No doubt the first septum is horizontal in the oospore of the mosses, and vertical or nearly so in that of the ferns; but in the opinion of the author that would be owing to a torsion of the embryo of the ferns. This is nothing more than an hypothesis. †

The "Micro-Megascopé."—This is the name given by Dr. Matthews to an apparatus that he has devised for exhibiting objects (such as sections of jaws, the foot of a frog, insects, &c.) which are too large to be viewed by the lowest object-glasses, the field of the 5-inch and 4-inch being respectively only $\frac{5}{10}$ and $\frac{4}{10}$ of an inch. They can first be reduced and examined by the apparatus as a whole, and any portion of them may then, by a readjustment of the objectives, be magnified as in an ordinary Microscope. The object is placed before a large condensing lens (on the opposite side being the source of light), and its image thrown upon the mirror, or preferably upon a prism, the reflected aerial image, formed by an objective placed in the sub-stage, being examined by the object-glass as the object. By this means the range of the Microscope is extended illimitably, as the object can be placed at different distances. Dr. Matthews claims that the instrument may rank higher than a "toy," though as a toy it is capable of producing very novel and pleasing effects. His attention was directed to the method by observing the image formed by the areolations in the valves of some of the diatoms, and the eyes of some beetles, and the instrument was described and exhibited by him at the February meeting of the Quekett Microscopical Club, and at the recent soirée.

* These differences depend perhaps on the diversity of the subjects observed. M. Jonkman, who has published in the 'Botanische Zeitung' (1878), No. 9, a study of the prothallus of *Marattia*, has represented the root as coming from one of the lower cells of the embryo.

† 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 121.

Chlorophyll.—M. Timiriaseff, in the Report before referred to of the International Congress of Botanists at Amsterdam, after some reflections on the various methods proposed for treating chlorophyll chemically, states that it is composed of two substances, the one yellow, xanthophyll; the other green, the cyanophyll of M. Kraus, which he proposes to call chlorophylline. This latter, spontaneously decomposing, produces chlorophylleine. Chlorophylline may again be decomposed under the influence of light or mineral acids, and changed into what M. Fremy calls phylloxanthine. Chlorophylleine in decomposing gives phylloxanthine.*

Professor Haberlandt considers that the chlorophyll in the cotyledons of *Phaseolus vulgaris* is formed from starch. The starch granules are gradually surrounded with a layer of protoplasm, which is at first colourless, but gradually turns green, while the starch grains disappear.†

Function of Chlorophyll in the green Planariæ.—Although the presence of chlorophyll has long been recognized in the tissues of a considerable number of Invertebrata, no reply has yet been given to the fundamental question whether it has the same function in the animal kingdom as in the vegetable. Can these animals effect the decomposition of carbonic acid under the influence of solar light with assimilation of the carbon and disengagement of the oxygen?

M. P. Geddes‡ has experimented on this subject at M. Lacaze-Duthiers' Laboratory of Experimental Zoology at Roscoff, where a species of green Planaria was found in great abundance, which had the habit of seeking and exposing itself to the light like *Hydra viridis*. They were generally found in the white sand in only a few centimetres of water. Placed in a small aquarium, they always sought the side of the light, and when the aquarium was exposed to the sun their movements were much accelerated. After some minutes bubbles of gas, small at first, showed themselves here and there, augmenting in number and volume with astonishing rapidity, equal to that of a green alga under similar circumstances.

The gas can be easily collected by placing the animals in a saucer, covered by another rather smaller turned upside down under the water. At the end of the day the volume of gas is sufficient to fill a small test-tube. If into this tube is plunged a nearly extinguished match, the white incandescence is produced characteristic of diluted oxygen. Ten or twelve of these tubes will collect enough gas to fill the long branch of the bent tube used for approximate analyses. Agitation with the potash solution shows only a trace of carbonic acid, but with the addition of pyrogallie acid the presence of oxygen is completely confirmed by the deep brown colour, and by the ascent of the liquid in the tube.

A series of tests gave 43 to 52 per cent. of oxygen. A similar analysis of atmospheric air, undertaken to ascertain the proportion

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 129.

† 'Monthly Jour. of Science,' 3rd ser., vol. i. (1879) p. 204.

‡ 'Comptes Rendus,' vol. lxxxvii. (1878) p. 1095.

of oxygen lost by this process, showed a loss of 5 per cent., and it may therefore be said that the gas developed by these animals does not contain less than 45 to 55 per cent. of oxygen, the residue being considered nitrogen.

It is easy to show the extreme importance of the action of light on the life of these animals. Placed in darkness after a journey from Roscoff to Paris, all died in two, three, or four days, whilst others exposed to diffused light decomposed carbonic acid and survived at least two weeks.

Treated with alcohol, the Planariæ give a first solution of a yellow colour, and after that, but somewhat less easily, a solution of chlorophyll of a magnificent green. The residue of the bodies of the animals, coagulated and discoloured by alcohol, boiled in water and filtered, gives a clear solution which treated with iodized water has the deep blue colour, which, disappearing by warming, proves the presence of a considerable quantity of ordinary vegetable starch.

Development and Metamorphoses of Tæniæ.—Thirty years ago Van Eeneden, Siebold, Leuckart, and Küchenmeister established, by experiments on carnivorous animals, not only that the vesicular worms were imperfect forms of Tæniæ, but that it was indispensable that the worms should be swallowed by an animal to bring them to the perfect state.

This view, while explaining the origin of the armed Tæniæ of carnivorous and some omnivorous animals, did not, however, explain that of the unarmed Tæniæ of herbivorous animals. The horse, ox, sheep, &c., often have adult Tæniæ, and yet they do not swallow any organism capable of harbouring the scolecides of their Tæniæ.

M. P. Méguin thinks* he has discovered the key to the enigma from an examination he made of some horses and rabbits. In these animals, the *Echinococci* and *Cysticerci*, when they develop in the adventitious cavities in immediate communication with the interior of the intestine (cavities resulting from the enlargement of follicles or glandules into which the hexacanthian embryos have introduced themselves), or even when they become free in the peritoneal cavity of the wild rabbit, continue their metamorphoses on the spot, and arrive at the adult state without quitting the organism into which they penetrated as a microscopic egg ($\cdot 03$ to $\cdot 07$ mm. in diameter) either with the food or drink of the animals. In this case, however, they give rise to an unarmed Tænia, whilst the same worm, if swallowed by a carnivorous or omnivorous animal, would become in its intestines an armed Tænia, that is, provided with the hooks of the scolex from which it originates, and which in the former cases it loses.

Some unarmed and armed Tæniæ are therefore two adult and parallel forms of the same worm, and the differences, often very great, which they present (as in the *Tænia perfoliata* of the horse and the *T. echinococcus* or *T. nana* of the dog which originate from the same worm), are due exclusively to the difference of the habitations in which their final metamorphoses are accomplished.

* 'Comptes Rendus,' vol. lxxxviii. (1879) p. 88.

Another Method of Staining.—Dr. A. Lang of the Zoological Station at Naples, having been occupied with the difficult histology of the Turbellaria, and particularly with the nerve-systems of these and other groups of flat worms, found that the method hitherto in use of staining the nerve-tissues was not satisfactory in all respects. It seemed to him to be most desirable to colour distinctly, in the nerve-system, not only the nucleus and the nucleolus, but also the vessels and the protoplasm of the ganglia. Many Dendrocœla with thick basilar membrane proved to be almost totally impervious to distinct colouring. To overcome this difficulty he made several experiments, and found the following mixture (which must of course vary with the nature of the object to be stained) to be beyond expectation:—

50 parts 1 per cent. picro-carminine.

50 parts 2 per cent. eosin (aqueous solution).

The objects, previously hardened in alcohol, are left in the mixture $\frac{1}{2}$ to 4 days, according to their size and their facility of imbibing the colour. Then comes the alcoholic treatment, which is as follows. The picrin is extracted by 70 per cent. alcohol, which must be frequently changed. Then 90 per cent. and absolute alcohol is added, the latter so long as any eosin is dissolved. In imbedding in paraffin the copious use of creasote is much to be recommended.

Dendrocœla stained in this way showed, on making sections, the most distinct colouring he ever obtained, and that for every part, but especially the nerve-system. Nucleus and nucleolus, glands, adipose tissues, &c., appear nearly carmine red, all the rest eosin red.*

Size of Society Screw and of Slides.—At a recent meeting of the State Microscopical Society of Illinois, Mr. Bulloch urged the desirability of adopting a uniform objective screw of larger size than the Society screw now in use, as being essential to the efficacy of low-power lenses of high angle. That the Society screw which has now become an almost indispensable convenience, is too small to admit of efficient work from these lenses, is (says the 'American Naturalist †) a conceded fact, and some makers in the United States who make low powers of enormous angle, have already adopted special screws for them. The uniformity urged by Mr. Bulloch is greatly to be desired and could be easily attained if its importance were appreciated in time.

In an article upon the preparation of rocks and fossils for microscopical examination by R. Fritz Gaertner, in the April number of the 'American Naturalist' for 1878, the advantages of slides measuring 25×45 mm., over those 3×1 inch, were stated to be as follows:—(1) They can be rotated on the stage, (2) they are less liable to break if dropped, (3) they take up less room. It was also stated that this size was adopted by the New York State Museum of Natural History, and by lithologists and palæontologists generally, both in Europe and America. These arguments seemed to Mr. S. H. Gage

* 'Zoologischer Anzeiger,' vol. ii. p. 45.

† 'American Naturalist,' vol. xiii. (1879) p. 60.

quite as valid as applied to microscopic objects in general; and he therefore adopted this size (25×45 mm.) for his own preparations, which he considers have proved very satisfactory indeed.*

The Termination of the Visceral Arterioles in Mollusca.—Thirty years ago Milne-Edwards showed that in different parts of the body of molluscs there were no capillaries, like those in Vertebrata, establishing a continuity between the arterial and venous systems, the blood from the arteries spreading through the more or less irregular spaces called *lacunæ* by Milne-Edwards.

In some molluscs the whole visceral cavity acts as one vast *lacuna*, and if for instance *Arion rufus* is injected by one of the tentacles, the cavity is first filled and then the whole vascular system.

M. S. Jourdain has investigated† the manner by which the arterial blood passes into the visceral cavity in *Arion rufus*.

If there is placed under the Microscope a fragment (cut tangentially) of one of the organs contained in the general cavity, and the external surface is examined under a power of 200 to 250 diameters, it is seen that the final ramifications of the arteries (the diameter of which is variable) all reach the free surface of the organs, and that there they terminate abruptly by a truncated and wide-mouthed extremity. It is by these orifices, nearly always widely funnel-shaped, that the arterial blood passes into the general cavity.

This curious anatomical disposition seems to have been observed by Alder and Hancock, though its true signification escaped them.

M. Jourdain thinks that the orifices of the so-called aquiferous vessels of the Acephala and other Molluscs are of the same nature as the arterial openings above described.

Hæmocyanin a new Substance in the Blood of the Octopus.—M. L. Fredericq has discovered‡ in the liquid part of the blood of *Octopus vulgaris*, a colourless albuminoid substance which he calls hæmocyanin (*αἷμα*, blood, and *κύανος*, blue) as it forms with oxygen a combination of a deep blue colour. A vacuum, or contact with the living tissues, is sufficient to drive off the oxygen.

This substance plays the same part in the respiration of the *Octopus* as hæmoglobin does in that of the Vertebrata. It is charged with oxygen in the branchiæ of the animal, and then going into the arterial system and the capillaries, it gives up the oxygen to the tissues. The venous blood is colourless, and the arterial blood a deep blue. These changes of colour are clearly due to the fact of respiration, as may be demonstrated by laying bare the great cephalic artery. The blood is seen to be blue while the animal respire normally in the water, but if the respiration is impeded by the animal being taken out of the water or by introducing the fingers into the pallial cavity, the arterial blood loses colour and takes a pale

* Mr. S. H. Gage, in 'Amer. Quart. Mic. Journ.,' vol. i. (1879) p. 160.

† 'Comptes Rendus,' vol. lxxxviii. (1879) p. 186.

‡ Ibid., vol. lxxxvii. (1878) p. 996, and 'Bull. Acad. Roy. de Belg.,' vol. xlv. (1878).

asphyxiated tint. The same takes place if the respiratory muscles are paralyzed by the section of the pallial nerves.

Hæmocyanin appears to be the only albuminoid substance in the blood, as is proved by the method of successive coagulations by heat. It is easy to isolate; being the only colloid substance in the blood, it is sufficient to subject the plasma of the blood to an energetic dialysis for three or four days so as to eliminate completely the salts and other diffusible substances. The liquid is then filtered and evaporated at a low temperature, when a blue brilliant substance is obtained in appearance like gelatine. It becomes blue in contact with oxygen, but colourless in a vacuum; coagulates in clots by heat, alcohol, ether, tannin, the mineral acids, and the greater part of the salts of the heavy metals. It burns with an odour of burnt horn and leaves a residue so rich in copper, that the blowpipe at once establishes its presence.

The copper seems to be in the same state as the iron in hæmoglobin and it plays an analogous part. Hæmoglobin may as is known be decomposed into ferriferous hæmatin and a coagulated albuminoid substance not containing iron. Hæmocyanin gives the same reaction. M. Fredericq has not yet been able to determine the proportion of copper or the proportion of oxygen with which it combines.

Chromatic Function in the Octopus.—M. Fredericq also finds* that the changes of colour in the skin of the octopus do not generally correspond to mimetic facts, but might rather be classed with the changes which the vasomotors produce in the human face. They express the different emotions, especially anger or fear.

A quick movement made before an octopus quietly breathing in the aquarium, renders a black spot immediately visible on the two extremities of the pupil, which dilates. The phenomenon disappears almost as quickly as it appeared. If the animal is excited still further, it gets into a great fury; its whole body assumes a dark colour, and the papillæ of its back bristle up. These changes of colour depend upon the central nervous system. The section of the nerve which goes to the muscles of the chromatophores is enough to paralyze the latter, and to bring on the passive phase of withdrawal of the chromatophores. That part of the skin served by the nerve immediately becomes pale, and then presents the minimum of coloration.

The excitation of the peripheral end of the nerve cut has precisely the contrary effect. In this case, all the chromatophores which depend upon it are brought into the condition of expansion, in consequence of the contraction of the radiating muscles; and the corresponding part of the affected surface presents the maximum of coloration.

Owing to their superficial situation and extended distribution, the pallial nerves are extremely well adapted for the demonstration of these facts.

In the normal state, the octopus generally presents a tint of medium intensity; the dilator muscles of its chromatophores are in a

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 1042.

state of *tonus*, or continual semi-tension. This state gives place to a relaxation of the muscles as soon as the nerves are cut; these latter then continually transmit to the periphery a certain amount of nervous influence, emanating from the nervous centres. The physiological centre of these movements of the muscles of the chromatophores is in the sub-oesophageal nervous mass, for the ablation of the supra-oesophageal mass does not produce the decoloration.

The contractility of the dilator muscles of the chromatophores may also be set in action by irritating the skin (after the section of the nerves) by electricity, heat, or a drop of acid, or by mechanical friction, which produces a dark spot.

The action of a very bright light has an entirely opposite effect; it makes those portions of the skin on which it acts grow pale.

The dark-coloured phase, therefore, represents the condition of activity of the muscles of the chromatophores. The phase of decoloration represents the passive condition of withdrawal of the chromatophores.

The results of these experiments thus establish the accuracy of the generally admitted conception of the histological structure of the chromatophore, and confirm the muscular nature of the radiating fibres of these elements.

New Classification of Thallophytes.—The classification of Thallophytes recently promulgated by Sachs,* is considered by Dr. G. Winter† to be unsatisfactory in many points. Independently of minor details, such as the location of *Volvox* among Zygosporæ, of Characæ among Carposporæ, &c., he objects to the main principle of the classification, the abolition of the hitherto recognized classes of Algæ and Fungi, and the establishment in their place of four classes of Thallophytes, each consisting of a series containing chlorophyll, and one destitute of it. It is impossible to maintain in many cases a near genetic connection between groups placed by Sachs in two series of the same class; as, for instance, between Zygnemæ and Mucorini; *Vaucheria* and *Peronospora*; Floridæ and Ascomycetes, &c. He considers the fundamental error, both in this classification and in that proposed by Cohn, to consist in laying too great stress on a single character, the mode of reproduction, to the exclusion of others; and proposes to retain the primary classification of Thallophytes into Fungi and Algæ. The former he divides into Schizomycetes, Saccharomycetes, Myxomycetes, Zygomycetes, Chytridiacæ, and Oomycetes (Basidiomycetes and Ascomycetes); the latter into Cyanophyceæ, Chlorosporæ (including Pandorinæ, Conjugatæ, *Vaucheria*, Volvocinæ, CEdogoniæ, *Coleochaete*, &c.), Fucoideæ, and Floridæ. The Basidiomycetes are divided into six families:—the Entomophthoræ (reproduced by basidiospores with secondary spores, and gonidia or gemmæ), Ustilagineæ (spores and sporidia, as well as conidia), Uredinæ (teleuto-spores and sporidia, as well as conidia or *Uredo*), Tremellinæ (basidiospores with sporidia, and spermatia or

* 'Lehrbuch der Botanik,' 4th ed., p. 248; see also Thiselton-Dyer, in 'Quart. Journ. Micr. Sci.,' vol. xv. (1875) p. 225.

† 'Hedwigia,' 1879, p. 1.

conidia), Hymenomycetes (basidiospores and conidia), and Gastromycetes (basidiospores, and gemmæ or portions of the mycelium). While the Fungi attain their highest development in the Ascomycetes, the Algæ pass on, through Characeæ, to the Muscinæ.

Fungoid Diseases of Plants.—*Disease of Chestnut Trees.*—M. J. De Seynes (in continuation of a paper by M. J. E. Planchon, previously published *) describes a disease which attacks the roots of chestnut trees.† The parasitic mycelium, which is analogous to that of certain Dematiei or *Zasmidium cellare*, forms a superficial network, and also one which penetrates the tissues and destroys the cellular layers which are the richest in protoplasm, the fibres of the liber and the woody fibres not being attacked. One of the symptoms of the action of the parasite is that the growth of the young radicles longitudinally is arrested, but the diameter increases, so that they ultimately form olive-like bodies, attached to the parent branch by pedicles.

In a subsequent paper,‡ M. Planchon, referring to the doubts he had expressed as to the species of fungus which the mycelium which attacks the trees gives rise to, states the reasons which “lead him to suppose to-day that the agaric in perspective is almost certainly *Agaricus melleus* of Vahl.”

Fungus, Disease in Lettuces (*Peronospora gangliiformis*, Berk.).—Lettuces have been invaded for some years, in France, by a disease which impedes the development of the plants, and spots and dries up the leaves. The havoc has been so considerable that a small body of market gardeners have offered a prize of 10,000 francs to whoever will put a stop to it.

M. Max Cornu has found§ that the disease is produced by a parasitic fungus (*Peronospora gangliiformis*, Berk.), which frequently attacks other plants, groundsel, and especially the artichoke, where the disease is hidden by the down of the leaves. It gives rise on the inferior side of the leaves to whitish mealy tufts, whence the popular name of “meunier” (miller).

In tearing off a strip of the epidermis of a lettuce attacked, we observe conidiophorous filaments, issuing through the opening of the stomata, as in other species of the fungus. They are in groups of two or three, or single; their superior part is variously ramified; the whole presents the appearance of a little tree. The little branches are dilated at their extremity, and bear from three to six sterigmata, which give rise to the conidia. These are broadly oval, with an incomplete papilla; the germination gives rise to a filament sometimes torulose in a remarkable manner.

The gardeners attribute the malady to the west winds, and to rainy and mild weather; it may be understood by this that these conditions favour the dissemination and germination of the spores on the young plants, for it cannot be a question of spontaneous generation.

* ‘Comptes Rendus,’ vol. lxxxvii. (1878) p. 583.

† Ibid., vol. lxxxviii. (1879) p. 36.

‡ Ibid., p. 65.

§ Ibid., vol. lxxxvii. (1878) p. 801.

When a crop of lettuces is suddenly invaded by *Peronospora*, where must the cause of it be sought? The cause ought to be attributed to the surrounding weeds, to the groundsel, artichokes, &c., already having the parasite. Sometimes, however, none of these plants are found in the neighbourhood: the spots are then produced by the germination of dormant spores or oospores, the second manner of reproduction of the parasite—oospores which germinate after a long time of repose, and may be preserved in the soil or on its surface, only requiring a little damp and heat in order to germinate.

These oospores are developed in the tissue occupied by the filaments of the mycelium, and dried up under its action. They are frequent upon groundsel, but very rarely appear on the lettuce, although their existence there is most probable.

If a transversal section is made of the leaf attacked, we see the mycelium creeping between the cells, and putting forth elongated ovoid suckers: when the exhausted tissue dies the mycelium disappears, and is itself the cause of its death. It is this change which is met with during the summer.

If the plant is more completely invaded, the conidiophorous filaments are more rare on the surface of the leaf, which is paler, and the leaf dies entirely without drying up; it grows soft, and turns brownish. This modification is generally produced outside the external leaves; and it is this which is found during the winter.

M. Max Cornu considered it possible to find in the cultivation of the plants and in the history of the parasite a means of guarding against its attacks; and presented to the Academy later some general considerations on the subject.*

Disease of the Coffee-tree originating from Anguillulae.—A disease has made its appearance in Brazil which rapidly kills the coffee-tree, an apparently healthy tree dying within a week from its leaves withering and falling off.†

On examining the roots of the trees they are found to be completely covered with swellings the size of hempseed, the root presenting the general appearance of a vine attacked by the Phylloxera. These swellings contain cysts with hyaline walls, which in their development destroy the fibro-vascular structures. Within the cysts are a number of ovules in all stages of development; those in an advanced stage are somewhat reniform, with a hyaline enveloping membrane, and within them is found coiled up a small *Anguillula*, about .25 mm. long, and without any trace of sexual organs. Each cyst contains from forty to fifty ovules, or about 30,000,000 *Anguillulae* per tree.

The animalcules, which are not reviviscent, when developed escape out of the cyst, leaving the cavity open, and the roots soon rot and are invaded by cryptogams.‡

* 'Comptes Rendus,' vol. lxxxvii. (1878).

† M. C. Jobert, in 'Comptes Rendus,' vol. lxxxvii. (1878) p. 941.

‡ See also a paper by the Rev. R. Abbay, on "*Hemileia vastatrix*, the so-called Coffee-leaf Disease of Ceylon," in 'Jour. Linn. Soc.' (Bot.), vol. xvii. (1878) p. 173.

Organization of *Hygrocrocis arsenicus*, Bréb.—This cryptogam was gathered for the first time in 1836, and presented to the 'Académie des Sciences' by Bory Saint-Vincent, who referred it to the genera *Hygrocrocis* or *Leptomit*, which de Brébisson confirmed by naming it *Hygrocrocis arsenicus*. In 1841 Louyet found it again in Belgium. Since then, although all druggists might have seen it in their bottles of arsenical preparations, it has not attracted any attention.

M. L. Marchand has recently studied it as developed in "Fowler's solution," and thus describes it: *—The invasion of the solution commences as an opaline cloudiness in suspension in the liquid. This cloudiness, examined under the Microscope, presents the appearance of a glairy mass containing brilliant points, fine dust, whose particles are so minute that they cannot be measured.

Later on, the spot increases and becomes coloured in the centre. The periphery remains glairy, but the centre (the oldest part) shows globules in tubes, whose walls, with age, become less undecided. These tubes are ramified, and then their contents become homogeneous. In proportion to their age the formation of septa takes place. The septa, at first widely separated, approach each other in such a manner that the dimensions of the cells become equal in all directions.

At first the mass remains opaline and floating in the liquid if the bottle has not been shaken; later on the cloudiness becomes dark towards the centre, and at last presents a brownish point, which increases and reaches the periphery; the opaline portions are invaded, and the mass, become brown, is precipitated at the bottom of the bottle. Examined under a low power, it resembles a little chestnut from 1 to 3 mm. in diameter, bristling with points. These points are the extremities of filaments, which for the most part have become torulose, knobbed and irregular, and some moniliform. From their protuberances start fresh filaments which ramify, or little blisters, which are hyaline and pyriform. The mass becomes more and more brown, and at last completely black; the plant is now in fructification.

If the elements which compose it are examined at this stage we find—

1st. That the filaments of the periphery are elongated inordinately into hyaline tubes, which terminate in a glairy mass, which envelops the organism and forms a cloudiness round it which resembles the cloudiness which first appeared; in this network and glairy mass float spores, and the debris of various organs.

2nd. That all the filaments of the centre have assumed new forms. The torulose moniliform filaments have increased and become almost entirely black. It is impossible henceforth to see their contents; they disarticulate with extreme facility, and the knobbed irregular filaments disarticulate with the same facility. They are less dark in colour, but the pyriform blisters which they have formed have become sporangioles of a very dark hue, particularly on the side of the point which attaches them to the filament; at their opposite part, which is

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 761.

swollen, they open by a dehiscence into two lips, and from each escapes from two to three colourless hyaline spores, evidently provided with a membrane. The extremities of these same filaments, which have remained regular, and whose cells are rectangular, and more or less elongated, terminate by bunches of spores, some rounded and arranged in unbellated rows around the superior cell; others, elongated into rods which become smaller and smaller in proportion as we approach the extremities, are in ramified bunches. Both resemble *Spicaria*.

We ought perhaps to class among the means of reproduction some bodies met with in fewer number than the preceding: they are larger than the spores of the sporangioles, are reticulated on the surface, and marked with a star, generally with three points; most often they are found free; in one case one of them seemed to be carried by a filament, and it seemed embraced at its base by two branches which were curved towards it.

M. Marchand draws the conclusion that *Hygrocrocis arsenicus*, formerly placed amongst the Algæ, is a fungus belonging to the Dematiæ; a practical confirmation of opinions given *a priori* by Decaisne, Bornet, Van Tieghem, &c.

¶The "Plastids" of the lower Plants.—M. E. Hallier has published a book on this subject, in which he deals with the parasitic diseases which attack the potato and the cabbage butterfly. The author dwells at length on *Peronospora*, which in his opinion is not a real parasite, but a saprophyte. He asserts that he has seen Bacteria and Vibriones originate from the *plastids* of *Peronospora*. He gives the name of *plastids* to the accumulations of protoplasm which are formed not only in the conidia, but also in the interior of the mycelium of this cryptogam. In his opinion the contagious character of the disease, and the cause of the alterations, are to be found in the existence of these agents of putrefaction, Bacteria or Vibriones. He has also studied another disease of the potato, which he thinks is due to *Pleospora polytricha*, Tul., although he has not proved by actual experiment that it is actually this *Pleospora*, a parasite on grasses, and moreover rare in Germany, which penetrates into the soil and thence into the tubercles of the potato to cause this disease. A very common Lepidoptera, *Pieris Brassicae*, is attacked by two diseases, a kind of *muscardine*, and a kind of *gattine*. The former is contagious, and is apparently reproduced by the conidia arising at the extremity of the filaments which have passed through the body of the insect. The second is caused by one of the Torulacei, and the author thinks that here again the contagion and disorders are not due directly to the joints of *Arthrococcus*, but to *Micrococci* developed in the plastids of this *Arthrococcus*.*

Staining for Fungi.—Dr. W. Hassloch has obtained excellent results in the examination of fungi by using gold chloride as a staining fluid. He employed a one-half per cent. solution, which stains

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 66.

in from one to six hours, and the specimens were mounted in diluted glycerine.*

Spines of Echini.—The last published part of the 'Transactions of the Royal Irish Academy' † contains a memoir by Mr. H. W. Macintosh, B.A., on the structure of the spines in the sub-order of the Desmosticha (Haeckel). In indicating four series into which, judging from the structure of the spines, this sub-order may be divided, the author expresses his opinion that the characters derived from the spines are just as useful as any other characters drawn from the comparison of individual parts. He finds it just as easy and as certain to recognize a Diadema, an Echinus, or an Arbacia by the structure of its spines, as by the arrangement of its pores or the disposition of its anal or genital plates. The paper is accompanied by three plates containing twenty-seven figures, all drawn by the author with the assistance of a Wollaston's camera lucida. The figures represent transverse sections of primary inter-ambulacral spines of some twenty-six species, and have been drawn on stone by Tuffen West with great care and accuracy.‡

The Locomotor System of Medusæ.—Mr. G. J. Romanes has concluded his observations on this subject, which were communicated to the Royal Society in a paper read in January last.§

The principal bulk of the paper is devoted to a full consideration of numerous facts and inferences relating to the phenomena of what the author calls "artificial rhythm." Some of these facts have already been published in abstract, || and to explain those which have not been published would involve more space than it is here desirable to allow. The tendency of the whole research on artificial rhythm, as produced in various species of Medusæ, is to show that the natural rhythm of these animals (and so probably of ganglio-muscular tissues in general) is due, not exclusively to the intermittent nature of the ganglionic discharge, but also in large measure to an alternate process of exhaustion and restoration of excitability on the part of the responding tissues—the ganglionic period coinciding with that during which the process of restoration lasts, and the ganglionic discharge being thus always thrown in at the moment when the excitability of the responding tissues is at its climax.

Light has been found to stimulate the lithocysts of covered-eyed Medusæ into increased activity, thus proving that these organs, like the marginal bodies of the naked-eyed Medusæ, are rudimentary organs of vision.

The polypite of *Aurelia aurita* has been proved to execute movements of localization of stimuli somewhat similar to those which the author has already described as being performed by the polypite of *Tiaropsis indicans*.

Alternating the direction of the constant current in the muscular

* 'New York Medical Jour.,' Nov. 1878.

† Vol. xxvi. (Science), Part 17.

‡ 'Nature,' vol. xix. (1879) p. 319.

§ 'Proc. Roy. Soc.,' vol. xxviii. (1879) p. 266.

|| 'Proc. Roy. Soc.,' vol. xxv. p. 226.

tissues of the Medusæ has the effect of maintaining the make and break stimulations at their maximum value; but the value of these stimulations rapidly declines if they are successively repeated with the current passing in the same direction.

In the sub-umbrella of the Medusæ waves of nervous excitation are sometimes able to pass when waves of muscular contraction have become blocked by the severity of overlapping sections.

Exhaustion of the sub-umbrella tissues—especially in narrow connecting isthmuses of tissue—may have the effect of blocking the passage of contractile waves.

Lithocysts have been proved sometimes to exert their ganglionic influence at comparatively great distances from their own seats—contractile waves originating at points in the sub-umbrella tissue remote from a lithocyst, and ceasing to originate at that point when the lithocyst is removed. A nervous connection of this kind may be maintained between a lithocyst and the point at which the waves of contraction originate even after severe forms of section have been interposed between the lithocyst and that point.

When the sub-umbrella tissue of *Aurelia* is cut throughout its whole diameter, the incision will again heal up, sufficiently to restore physiological continuity, in from four to eight hours.

Tetrapteron volitans.—This peculiar marine hydrozoon was imperfectly described in 1851 by M. Busch, who named it *Tetraplatia volitans*. It has now been re-discovered by Professor C. Claus, who gives it the name at the head of this paragraph.*

The animal in the extended condition is of an elongated pear-shape, but four-sided instead of circular in section; the smaller end bears the oral aperture, and answers to the manubrium of a medusa, the larger or aboral end answering to the bell. At the middle (that is, half-way between the oral and aboral poles) of each of the four faces is a depression, from which springs a bilobed wing-like appendage, provided with museles, by the flapping of which the animal is propelled through the water, with the aboral pole forwards. In each division of each wing is an otolithic sac. The mouth leads into an enteric cavity, which is continued into the aboral portion of the hydrosoma. Reproductive organs occur as four masses, probably ectodermal products, in the four longitudinal edges of the body.

The ectoderm consists of large ciliated cells, some of which contain thread-cells, while in others the protoplasm is so modified as to form a gland, presenting a distinct aperture, and a radiating arrangement of the glandular contents. The endoderm cells are so extensively vacuolated as to form a mere network of plasma-threads. The vacuoles probably contain the albuminoid products of digestion; in some of them small aggregations of crystalline rods are found, probably the final products of urinary metabolism. Amongst these vacuolated cells smaller granular endoderm cells occur at intervals, two or three together.

Between the ectoderm and endoderm is a structureless connective

* 'Archiv f. Mikr. Anat.,' vol. xv. (1878) p. 849.

lamella or supporting layer (Stützlamella); it is very thick in the wings, and serves for the attachment of the muscles.

The author concludes with a discussion of the affinities of *Tetrapteron*, which he considers to hold an intermediate place between Polypes and Medusæ.

The Algæ of the White Sea.—This paper, by Dr. C. Gobi, in the Memoirs of the St. Petersburg Academy,* is the first detailed account of the algæ of the White Sea. The species are principally those found throughout the Arctic Ocean; but Dr. Gobi remarks that the vegetation of the southern part of the White Sea has a more northern character than that of the northern part, which is explained by the statement that many forms of Western Europe which make their way to the northern part do not extend to the southern part. Dr. Gobi unites a considerable number of species considered by Agardh and others to be distinct, even regarding *Rhodomela lycopodioides* as a form of *R. subfusca* and *Polysiphonia arctica* as a variety of *P. variegata*. *Rhodophyllis veprecula*, Ag., is referred to *R. dichotoma*, Lepechin. The new species and varieties observed and studied by Dr. Gobi amount to nine, and the total number of species gathered to seventy-six.

The paper contains valuable references to the species of Ruprecht in the Academy's herbarium.

Achromatic Lenses.—Mr. E. M. T. Tydeman, of Liverpool, has obtained provisional protection for an invention which we describe nearly in his own words, as appearing in the printed specification:—"My invention consists of improvements in the construction of compound achromatic lenses suitable for use in Microscopes and other optical instruments, and is intended more completely to eliminate the large irrationality or want of correspondence between the coloured spaces in the various spectra (secondary spectrum), and to render the lenses more perfectly achromatic. It consists in forming the lenses, not as hitherto by the union of lenses made of different kinds or species of glass or other refractive media, but of one kind or species only, yet of different densities and refractive powers, in which the irrationality or unequal refraction of the coloured rays is not so great. I therefore construct my improved achromatic lenses with two or more glasses made from material of the same kind or species of glass (such as that known as flint glass, which is capable of being made of varying density), but of different densities or refractive indices; and I also use flint glass lenses in lieu of the usual crown or plate glass lenses in achromatic object-lenses. For a Microscope object-glass—often composed of two or more approximately achromatic lenses, or set of lenses, either in contact or nearly in contact—I sometimes make one of the several sets of compound lenses of one refracting medium, such as flint glass, and the other set or sets, or single lenses, of a different refracting medium or media, or I use single lenses of crown, or flint, or any other substance in combination, though not necessarily in contact with an

* 'Mem. Imp. Acad. Sc. St. Petersburg,' vol. xxvi. (1878); 'Amer. Jour. Sci. and Arts,' ser. 3, vol. xvii. (1879) p. 71.

achromatic set composed wholly of flint glass or any other suitable refracting substance."

In connection with this subject, we may refer to a paper read by Professor Stokes at the Royal Society,* in which he describes an easy, and at the same time accurate, method of determining the ratio of the dispersions of glasses intended for objectives—a method depending on the achromatizing of one prism by another.

Development of *Spongilla fluviatilis*.—Professor Ganin, of Warsaw, has undertaken some investigations to decide the following morphological questions:—Does the gastrula stage exist in the developmental history of *Spongilla*? and if it exists, what is its ontogenetic significance? In what way are the germ-layers formed, and in what relation do they stand to the adult structures of the sponge? Does the so-called *syncytium* of Haeckel exist in *Spongilla*? Is the entoderm in sponges confined to the so-called ciliated chambers and their homologues (radial tubes of the Sycones)?

In opposition to Haeckel's views on this last question, it is stated by F. E. Schulze, Barrois, and Metschnikof, that the ciliated chambers (radial tubes) do not open into the digestive cavities, but into cavities or canals which are lined with a continuation of the ectoderm. If this last view of the morphological import of the internal cavities of sponges is correct, the homology of their canal system with the gastro-vascular system of the Cœlenterata disappears, and the place of sponges in the latter group has still to be demonstrated.

The answer to all these questions will be found in the author's forthcoming work, 'Contributions to the Anatomy and Developmental History of Sponges,' of which the following is a brief summary of the more important results.

The ovum of *Spongilla* undergoes a complete segmentation into equal-sized blastomeres, a solid globular mass of cells—the so-called morula—being produced. The peripheral cells of the embryo then begin to multiply more quickly, and thus become distinguished from the larger and darker cells of the inner mass. In this way the two primary germ-membranes, the (primitive) ectoderm and entoderm, are differentiated from each other. Simultaneously with the commencement of this separation, a cavity is hollowed out in the interior of the central mass of entoderm, as the result of the disaggregation and dissolution of its cells. This gastric cavity never opens during the whole period of embryonic development, or during the free existence of the larva. The morula stage passes first into the so-called plano-gastrula or planula stage—a larva of regular oval form, with large internal cavity, and without any external opening. The inner series of the cells of the primitive thick entoderm mass alter their form and structure at an early period, and become the actual entoderm of the adult. The remainder of the entoderm mass forms the mesoderm of the larva. This consists of several rows of dark granular cells, filled with rounded yolk-spheres. The spiculæ of the skeleton begin to develop very early in the interior of the mesoderm cells. The body of the ovoid

* 'Proc. Roy. Soc.,' vol. xxvii. (1878) p. 485.

free-swimming larva thus consists of three different germ-lamellæ. The ectoderm is formed of a series of flagellate cylinder-cells. The mesoderm is a much thicker mass, consisting of rounded amœboid cells. The entoderm is formed of a single row of transparent flat polygonal cells. At the posterior narrow pole of the larva an accumulation of the mesoderm cells takes place at an early period, and occupies nearly a third or a half of the length of the larva. In the anterior clear part of the larva there is found a large gastric cavity. The skeleton is confined to the posterior dark part of the larva. On the external surface of the free-swimming larva are seen a number of ectodermal processes, of different shapes and sizes, which are of no morphological signification. Between the ectoderm and mesoderm of the larva is seen a clear interval, into which the processes of the mesoderm cells project in many places, and which is to be regarded as the body-cavity. The posterior mass of mesoderm grows forwards, as a result of which the stomach-cavity becomes very much narrowed. The larva fixes itself by means of the ectoderm cells of its posterior half, and soon loses its original form and assumes a flat discoid shape. Transverse sections of the body of the larva in such very early stages of the metamorphosis, prove that the at first simple gastric cavity does not disappear, although it is much altered by the great increase of the mesoderm, but passes immediately into the entodermal cavity of the adult *Spongilla*. Very soon after the larva becomes fixed, a number of the so-called ciliated chambers make their appearance simultaneously at several points in the mesoderm; their development depends upon out-pushings of the entoderm. The histological differentiation of these ciliated chambers, which at first are covered with flat cells, takes place somewhat later, after the first central opening of the young *Spongilla* has been formed. This first opening, which must be regarded as the oral aperture, is not formed by invagination of the ectoderm (Barrois), but by a breaking through of the mesoderm and entoderm cells on the upper walls of the stomach-cavity. The oral orifice of *Spongilla* differs from that of other animals in that it does not open externally directly, but into a special cavity, which is to be considered as the body-cavity. The ectoderm and entoderm are always separate in *Spongilla*; the margins of the oral aperture do not become fused with the ectoderm. Soon after the formation of the oral orifice, some of the so-called "ingestive apertures" make their appearance. In the matter of development, structure, and relation to other parts, these structures are perfectly homologous with the oral aperture.

The further development of the young *Spongilla* depends upon the increase of the histological elements of the three membranes, in such a way that each membrane gives rise only to elements of the same morphological significance. The formation of the ciliated chambers by division or by budding of old already-formed chambers, I have never seen. The so-called osculum is homologous, as its development shows, to the porus dermalis. It consists of two layers only (mesoderm and ectoderm). The full-grown *Spongilla* is formed of three different membranes, which originate directly from those of the same

name in the larva. From the ectoderm of the larva is formed the external layer of the skin, which in *Spongilla* consists of two distinct layers, the epidermis and cutis. The larval entoderm forms the thin single-layered lining of all internal cavities or canals (the body-cavity excepted), as well as a covering to the mesodermal septæ, trabeculae, &c. The mesoderm of *Spongilla* may be regarded as a simple form of connective tissue in which the cell element prevails, and the structureless gelatinous matrix is very slightly developed. A synectium, in Haeckel's sense, does not exist in the *Spongilla*. Fusion of *Spongillae* of different forms and sizes never gives rise to the formation of the so called pseudo-oral orifices, pseudo-enteric cavities, communicating canals, and other cavities coated with ectoderm.

We can distinguish in sponges two different modes of development. One group of sponges show in their developmental history a well-pronounced blastula stage, i. e. a hollow single-layered sac with a large segmentation cavity in the interior. Some of those sponges, as *Halisarca lobularis*, *Dujardinii*, *Ascetta primordialis*, *A. clathrus*, have an archiblastula stage; in others of the same group (*Sycandra raphanus*, *compressa*, the calcareous sponges of Barrois), the modified *amphiblastula* form obtained. In this form of the generation cycle the two primitive embryonic membranes originate by the cells of the posterior half of the sac undergoing differentiation into the primitive entoderm, whilst the cells of the other half of the blastula give rise to the ectoderm of the larva. The formation of the gastric cavity in this case depends, in all probability (as F. E. Schultze and Barrois have already noticed), upon the invagination of the posteriorly-situated entoderm, in the interior of the segmentation cavity of the embryo. But whether the aperture of invagination of this provisional archigastrula passes directly into the actual oral orifice of the sponge, remains to be proved. The sponges of the second group begin their ontogeny with the morula stage (all siliceous sponges—*Spongilla*, *Esperia*, *Reniera*, *Amorphian*, *Desmocidon*, *Isodictia*, *Raspailia*; also the calcareous sponges of Haeckel). The formation of all three embryonal membranes depends in this case on the delamination process. The stomach cavity of the larva is formed by the separation and dissolution of some cells of the interior of the entoderm mass. In place of the gastrula, the plano-gastrula makes its appearance. The generation cycle with the blastula stage is to be regarded as the most simple. To this corresponds also the much simpler organization of the sponges of this group: *Halisarca*, for example, has no skeleton, is everywhere covered with the ectoderm of the larva, &c. The sponges which in their developmental history pass through the morula stage, are also more complicated in morphological and histological respects. The place of the sponges as a particular class of the Celenterata is entirely natural, on the ground of all the facts hitherto known of comparative anatomy and embryology.*

Mr. F. M. Balfour refers shortly to the above in the article next mentioned, and considers that M. Ganin's account of the development of *Spongilla* is not reconcilable with that of *Sycandra*, as described

* 'Zoologischer Anzeiger,' vol. i. (1878) p. 195.

by Professor Schulze, and that, "considering the difficulties of observation, it appears better to assume for this and some other descriptions that the observations are in error rather than that there is a fundamental want of uniformity in development amongst the Spongida." It would be superfluous for us to lay stress on the value of Mr. Balfour's opinion on such a matter as this.

Morphology and Systematic Position of the Spongida.—In an article in the 'Quarterly Journal of Microscopical Science,'* Mr. Balfour points out that Schultze's last memoir † on the development of Calcareous Sponges confirms and enlarges Metschnikoff's earlier observations, ‡ and gives us at last a fairly complete history of the development of one form of calcareous sponge; and the facts thus established have suggested to him a view of the morphology and systematic position of the Spongida somewhat different to that now usually entertained, though it does not claim to be more than a mere suggestion, which, if it serves no other function, may perhaps be of use in stimulating research.

After a brief statement of the facts which may be considered as established with reference to the development of *Sycandra raphanus*, the form which was studied by both Metschnikoff and Schulze, Mr. Balfour says that he thinks that the larva represents an ancestral type of the Spongida, consisting of a colony of Protozoa, one-half differentiated into nutritive, and the other into locomotor and respiratory forms, thus constituting a link between the Protozoa and Metazoa. He accounts for the ciliated cells becoming invaginated to form part of the lining of the gastrula cavity, by supposing that on the ancestral sponge becoming fixed the locomotive ciliated cells increased in size and number less than the nutritive, and so came to line the cavity of the gastrula, some of the nutritive subsequently passing in at its mouth. In the adult sponge he thinks the descendants of the latter cells which line part of the canals to be alone digestive, the collared cells, the descendants of the ciliated cells, of the larva being mainly respiratory.

Sponge - spicules.—In concluding an article on *Plectonella papillosa*, a new genus and species of Echinonematous sponge, § Mr. W. J. Sollas says that regarding the various kinds of sponge-spicules as resulting from a variously modified cell-growth, the relations subsisting between the chief of them may be embodied in a diagram.

1. An elongate growth of the original cell in two opposite directions at equal rates gives us the ordinary acerate spicule (Fig. 1), which is biradiate (diactinellid) but uniaxial.

2. A retardation of growth in one radius gives the acuate spicule of Fig. 2.

3. A linear growth in one direction only gives the acuate (Fig. 3);

* N. S., vol. xix. (1879) p. 103.

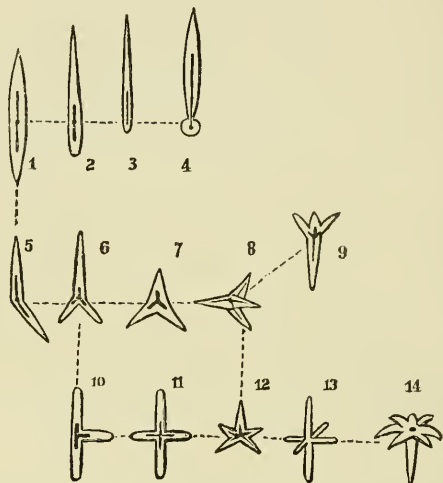
† "Untersuchungen über d. Bau u. d. Entwicklung der Spongien," 'Zeitschr. f. wiss. Zool.,' vol. xxxi. (1878).

‡ Ibid., vol. xxiv. (1874).

§ 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. iii. (1879) p. 23.

if accompanied by increased concentric growth of the initial cell, then the pin-headed acuate (Fig. 4) is produced.

4. An elongation of the cell in two directions, inclined to each other at a less angle than 180° , gives us the curved accerate (Fig. 5), which is both biradiate and biaxial.



5. The inclination of the two rays in Fig. 5 is followed by the appearance of a third in Fig. 6, where we have the triradiate spicule of *Plectonella*. In this spicule two of the radii arise from the proximal face of the cell and grow inwards towards the axis of the fibre on which it is situated, and the third ray arises distally and grows outwards away from the axis.

6. A growth of the cell in three directions making equal angles with each other, and having no determinate relations to any symmetrical line within the sponge, gives us the equiangular triradiate spicule (Fig. 7), which occurs abnormally in *Dercitus Bucklandi*.

7. A quadriradiate growth of the cell in directions having no determinate relations to the form of the sponge gives us the normal spicule of *Dercitus Bucklandi* (Fig. 8).

8. The cell gives off three buds from its distal face, which grow outwards away from the sponge, and a fourth from its proximal face, which grows inwards, and we have the forked forms of *Geodia* and the like (Fig. 9).

9. The cell grows in five directions along three axes at right angles to each other, which are not determinately related to any lines of reference within the sponge (*Dercitus Bucklandi*), or which are so related (*Euplectella* and other Hexactinellids), and we have the quinqueradiate form (Fig. 12).

10. In Fig. 6 the growth of the three rays is along directions inclined somewhere about 120° with each other; if two of the rays grow in opposite directions, and the third at right angles to them,

Fig. 10 results (a form abnormal in *Plectronella*, frequent among the Hexactinellidæ).

Fig. 11 requires no comment.

Fig. 13 is the result of a sexradiate growth of the cell along three axes at right angles to each other, and represents the typical Hexactinellid spicule.

Fig. 14 is an octoradiate form, seven buds having grown out radiately in one plane and the eighth at right angles to them; it occurs in the fossil *Hyalostelia*.

The foregoing remarks arose out of the description of *Plectronella papillosa*, which was the main object of the paper; but the variability of sponge-spicules, Mr. Sollas points out, is far too important a subject to be treated thus incidentally, and might furnish material enough for a lengthy memoir. No sponge that has come under his observation has failed to exhibit numbers of spicules departing more or less widely from the average type; frequently the range of variability is extreme; and no doubt, when a large number of specimens of allied species of sponges come to be carefully compared, we shall find not only in their external form, but in the details of their internal structure as well, easy passages from one to the other, and links will be discovered uniting together types of sponge-structure that now appear widely separated from one another.

Gloidium, a new genus of Protista.—This genus, recently discovered by Dr. N. Sorokin, of Kasan,* differs in many respects from any of the hitherto known forms of Protista. It is a minute myxopod ($\cdot 03$ mm. in diameter), with short, blunt pseudopodia, and protoplasm distinctly differentiated into a clear transparent ectosarc, and a frothy-looking endosarc containing reddish or yellowish granules. There is no nucleus, but a large contractile vesicle in the ectosarc, contracting about every three or four minutes.

Multiplication takes place by division, the process being a somewhat singular one. Constrictions appear in the protoplasm at the opposite poles, and soon after two similar constrictions, the plane of the second division being at right angles to that of the first. Then the pairs of constrictions deepen, extending nearer and nearer to the centre, until, at last, four masses are produced, united to one another by as many delicate threads of protoplasm proceeding from a common point: finally, the four masses become free. At first there is a single contractile vesicle in the centre of the dividing mass, but as division goes on, each mass is provided with a pulsating organ.

The author failed to see any food particles in the endosarc, and supposes that the organism is nourished entirely by imbibition. It is, therefore, devoid of one of the most constant animal characteristics—the power of ingesting solid nutriment.

Under certain circumstances not well understood, encystation takes place. A thin, scarcely noticeable investment is formed by the hardening of the superficial layer of ectosarc. Fresh layers are found in the same way, until a laminated cyst is produced. At one spot all

* 'Morphologisches Jahrbuch,' vol. iv. (1878).

the layers but the outermost one are undeveloped, so that a funnel-like canal is produced, separated from the exterior only by the thin outer layer of the cyst; into this canal—the “germinal pore” (Keimporus)—the protoplasm extends, and after a time escapes through it, by the rupture of its thin outer covering. The process of encystation takes one and a half to two hours; the organism remains encysted from two to three days. After escaping from its cyst, it is slightly smaller than before. No union of different individuals into a plasmodium was observed, so that the life-history of *Gloidium*, as at present made out, is an extremely simple one, presenting merely an alternation of the free and encysted condition.

Preparation of Microscopic Aquatic Animals.—An anonymous writer in the Berlin ‘*Zeitschrift für Mikroskopie*’* gives an account of a process which he has made use of for preparing slides of Infusoria, Rhizopods, Daphnia, Cyclops, Algæ, &c. The only successful attempt in modern times to supply the want of such a process is that of Duncker, of Bernau,† but this, for trade reasons, is kept secret. The author’s process, which he thinks may be identical with Duncker’s, is as follows:—

By means of a pipette, some drops of the liquid, containing the organisms to be mounted, are introduced into a lac cell not quite hard, and covered with the covering glass. Then some drops of rectified pyroligneous acid (acetum pyrolignosum rectificatum) are placed at the edge of the covering glass so as to be drawn into the cell. This liquid immediately kills all the organisms without altering their form. It only remains to cement the cover down in the usual way. When the pyroligneous acid has become turbid, it must be filtered before being used.

With this method may be combined the staining of the objects by anilin colours. Dissolve one part (in weight) of a solution of anilin colour (the best are anilin blue or diamond fuchsin) in 200 parts of distilled water; after filtering, add 800 parts of pyroligneous acid. Then with this liquid proceed as with the pure acid. After some hours, the objects take a very uniform colour; they are then mounted as above, after adding a little more pure acid. If the colour is too dark, it can be made lighter with acid. The author thinks that his process is capable of improvement, although he has already obtained excellent results from it, and he lays stress upon the facility with which it can be used in travelling.

The Postal Microscopical Society.—This Society was first established in 1873, as the “Postal Micro-Cabinet Club,” for the purpose of affording a ready means of communication between microscopists living not only at a distance from each other, but also from London and the other large towns having Microscopical Societies.

The Society is divided into circuits of twelve members each, whose names are arranged geographically. A box of slides is sent by the secretary (Mr. Alfred Allen, of Bath), at fortnightly intervals,

* ‘*Zeitschrift für Mikroskopie*,’ vol. i. (1878) p. 273.

† This Journal, vol. i. p. 221.

to the member whose name stands first on the list, who should keep it three evenings only, and then send it to the next name, and he to the following one, the last on the list returning it to the secretary, by whom it is sent to the next circuit, and so on. Each box is accompanied by one or more MS. books, in which the members are requested to make remarks on the slides.

From the Fifth Annual Report it appears that the Society numbers 140, including six ladies who are now eligible for membership. In the Address of the President, Mr. Tuffen West, F.Z.S., F.R.M.S., the safe transit of slides and the best form of postal box were among the principal topics dealt with.

A special feature is the requirement of the Society that each member on admission shall send his *carte de visite* to the secretary. They are then grouped (sixty or seventy together) and reproduced in permanent photography by the Woodbury process, and supplied to the members.

It is intended to circulate a separate series of histological and pathological slides amongst the medical members.

Life-History of the Diatomaceæ.—M. Paul Petit, whose observations on the revivification of diatoms will be remembered,* contributes to the French Botanical Society some further remarks† on diatoms. That so little is known of their life-history is, he thinks, the fault of the “diatomophiles,” who have preferred to create new species or to count the number of striae on the valves rather than to devote themselves to physiological researches. The impossibility (as M. Petit considers) of growing diatoms in an aquarium, as can be done with others of the lower cryptogamia, necessitates the noting of all the phenomena which are met with in nature. We shall thus, sooner or later, understand the ensemble of the phases through which diatoms pass during their existence.

He accordingly describes the following observations made by Professor Brun, of Geneva:—

On the 5th–7th of January, 1878, M. Brun gathered some mud which covered the rocks at the lower part of the Mer de Glace at Chamounix (1150 metres). Deep snow covered the valley and the mountains, the thermometer standing at 18° (C.) below zero; but as the ice melts in contact with the rock (even in winter), the rock is thus moistened by water at zero. The mud contained a great quantity of diatoms and some desmids, all in a perfect state of vegetation. Lower down in the valley a small piece of water at 0°, covered with ice, was overrun with *Melosira varians* in full vegetation.

Some specimens from the mud of the Mer de Glace were sent to M. Petit by post, and he found that the endochrome of all was in a perfect state, and that the *Naviculæ* exhibited their movement.

The second observation was made in the Valais, on the Bella Tola, at 2600 metres, on the 19th and 20th January. The temperature was 9° below zero, and the snow was lying thick. Here also M. Brun found that the algæ and diatoms were living wherever the snow melted in contact with the warmer rock, and where the light reached.

* This Journal, vol. i. p. 26.

† ‘Brébissonia,’ vol. i. (1878) p. 81.

The specimens sent to M. Petit contained *Melosira arenaria* nearly pure, containing only a few frustules of *Surirella spiralis* and *Epithemia helvetica*. It was easily seen at the first examination under the Microscope that they were in full vital activity.

Thus, according to these observations, diatoms continue to live, and even to develop, in water at 0° with a surrounding temperature of 9° to 18° below zero, provided always that they receive some rays of light.

M. Petit further says that "it is extremely curious to find at these great altitudes species which are found in the plains; it is impossible to distinguish any difference between the Alpine species and the others."

Movements of Diatoms and Oscillatorieæ.—The comparatively rapid movements in the water of diatoms and of certain desmids, and the wavy motion of the Oscillatorieæ, are among the most familiar phenomena to microscopic observers; but their cause is at present involved in much obscurity.

Professor Engelmann, of Utrecht, who has undertaken extensive observations on the subject, thus sums up our present knowledge.* The most probable explanation at present offered, he considers to be that of Max Schultze,† who attributes them to the movements of contractile protoplasm which covers the outer surface of the solid cell-walls; a hypothesis which is confirmed by the following considerations:—Diatoms exhibit this power of motion only when in contact with a solid substratum; they never swim freely through the water; which contradicts the hypothesis that the motion is due to vibratile cilia or to osmotic currents. The phenomenon is especially marked when they lie upon one of their so-called "sutures," and the motion is always in the direction of this suture, either forwards or backwards. Foreign bodies, such as grains of indigo or other pigments, easily become attached to the surface when in contact with a suture, and are moved up and down along it. This motion of the foreign particles takes place only when they lie upon one of the sutures, and then whether the diatom itself is in motion or at rest.

In the case of Oscillatorieæ, the following observations have been made by Siebold:‡—If the water in which these bodies grow is coloured by indigo, the particles of this pigment which come into contact with the separate *Oscillaria*-filaments collect into a rather narrow spiral running round the filament to its apex, whether the filament is in motion or not. Sometimes these creeping spiral lines of pigment begin to be formed at both ends of the filament, and meet in the middle, where the particles become heaped up into little balls; or sometimes they begin in the middle and advance to both ends of the filament. The mode in which the particles of indigo adhere to the alga and to one another appears in this case also to indicate an excretion of mucilaginous protoplasm by the former. Cohn § subse-

* 'Botanische Zeitung,' vol. xxxvii. (1879) p. 49.

† 'Archiv für Mikr. Anat.,' (1865) pp. 376-402.

‡ 'Zeitsch. für wiss. Zoologie,' vol. i. (1849) p. 284 *et seq.*

§ Cohn, in 'Archiv für Mikroskopische Anatomie,' vol. iii. (1867) p. 48.

quently noted the same peculiarity with regard to Oscillatorieæ that had previously been observed in the case of diatoms :—that their oscillating movements take place only when they are in contact with a solid substratum.

This explanation has up to the present time been a hypothetical one; but the external secretion of protoplasm, which Schultze, Siebold, and Cohn had been unable to discover, has at length been detected by Engelmann in the case of a large oscillatoria, *Oscillaria dubia*, Kütz. The method by which he at length succeeded was by passing induction currents through the water in which the alga was growing; when after a few seconds, an excessively thin coating, to which the foreign particles were here and there attached, lifted itself from the surface of the alga, but never to a greater distance than about 0·008 mm. The same took place after the careful addition of dilute potash, the protoplasm subsequently entirely disappearing, which it did also gradually on addition of dilute hydrochloric acid and 10 per cent. solution of sodium chloride. With eosin and picro-carmin the thin layer became distinctly coloured. The protoplasmic layer was also subsequently made visible by the sudden addition of strong nitric acid. It is probable that the immobile thread-like cilia, coloured yellow by iodine, which had been detected in some Oscillatorieæ, as *Oscillaria viridis* and *Phormidium vulgare*,* may be portions of the same external protoplasm.

The Use and Abuse of Diatoms as Test Objects.—The following remarks are not strictly new, but at the same time we do not remember having previously seen the matter so well put. They occur in a paper by Mr. G. D. Hirst, the secretary of the Section of Microscopical Science of the Royal Society of New South Wales (“Notes on some Local Species of Diatomaceæ”), in the volume recently issued of that Society’s ‘Journal and Proceedings’:†—

In conclusion, I would say a word in reply to questions I have heard put sometimes, when, after the expenditure of much time, trouble, and patience, adjusting of light and mirror, the lines on some difficult test diatom have at last been fairly displayed: “Well, what good have you accomplished? In what respect is microscopic science benefited by the fact that such a diatom has so many lines to the inch?” There are, I know, many microscopists who affect to despise those whom they call “Diatomaniacs,” and count the time and trouble expended in the resolution of markings as simply wasted. Now, without for a moment arguing that the only or chief work for the Microscope is counting the striæ on diatoms, I would hold that the time spent in successfully resolving a difficult test is by no means wasted. The tyro, sitting down before his newly acquired instrument, places an object on the stage, turns on the full glare of light from his mirror and condenser, and fancies he sees everything to perfection. Let him try the same method of proceeding on some delicate diatom-valve; and where in the hand of the skilful manipulator a moment

* Nageli, in ‘Beiträge zur wissenschaftlichen Botanik,’ vol. ii. (1860) p. 91.

† ‘Journal and Proceedings of the Royal Society of N. S. Wales,’ vol. xi p. 272.

before, lines or beading were beautifully displayed, he sees a blank. He may spend long hours in trying every trick of illumination, moderating his light, varying its obliquity by altering the angle of his mirror, focussing and re-focussing the condenser, altering the adjustment of his objective; and at last, when his patience is well-nigh exhausted, the desired result is obtained, the delicate markings start suddenly into view, and he possesses the consciousness that, under his hands, mirror, condenser, and objective are now doing their best. Has this time been wasted? I think not. He will carry the knowledge obtained in the struggle, and apply it in the broad field of real work that lies before him on every side. Should he turn his attention to the development of minute life, organs are seen in living transparent bodies where before he saw nothing; should he be a pathologist, tissues appear full of structure which before in his inexperienced hands seemed homogeneous, minute nerve-fibres become visible where before they were unsuspected. I do not think I am exaggerating in saying what I have; I have felt the benefit conveyed in an education of this kind, and I could recommend nothing better for a beginner than a year's constant study of all the species of *Diatomaceæ* at his command. When he is fully convinced that he sees all in them that his optical means will allow, he is far better fitted to commence real work than he ever could have been without this preliminary training. Only, let us not mistake; our work, though commencing on diatoms, should not end there; let their delicate lines be the means of familiarizing ourselves with the optical capabilities of the noble instruments at our disposal, and the questions I have quoted will be duly answered—the time spent will not be in vain.

To the same effect are some remarks made by Mr. J. Mayall, jun., in an address on "Immersion Illuminators," recently delivered before the Brighton and Sussex Natural History Society:—"Practice with diatoms should be regarded as the gymnastics of the Microscope. To ignore this practice is voluntarily to paralyze our possible skill, which cannot be done with impunity, as is proved by the immense mass of old results that are constantly being discarded to make way for interpretations based on more perfect instrumental and manipulative means. The improvements in the Microscope are almost wholly due to the criticisms of amateurs skilled in the exhibition of test objects."

Measurement of the Amplification of Optical Instruments.—The following was communicated by M. Govi to the French Academy, and, being printed in their 'Proceedings,'* we have thought that a translation might properly find a place here. Those who may not altogether agree with the views expressed, may still find some interest in the fact of the paper having been accepted by the Academy:—

By amplification is meant the relationship of size between the image and the object. The idea of size, obtained by looking at an image, without actually measuring it, is not in any way precise.

If optical instruments only gave *real* images, their magnifying

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 726.

power would be very easily determined, and there could be no dispute as to it. *Virtual* images have, nevertheless, quite as measurable a size as real images, and have, like the latter, a determinate place in space.

We must not, then, gratuitously suppose that the eye constantly refers them to the distance of distinct vision, because, first of all, such a distance does not exist for normal eyes, and that, if even it did exist, it would not be of any use for the measurement of the amplification; since each observer, and the same observer every time that he re-focusses an image, places it, or may place it, at a different distance.

It is sufficient, to prove this, to make several people focus an image, and examine its distance every time, by means of a *megameter*,* a little astronomical telescope with graduated draw-tube and micrometer eye-piece. It is thus found that nearly all the focussings give different distances.

The megameter enables us, besides, to measure, in every case, the actual size of the image, by referring it, by the micrometer eye-piece, to a divided scale, looked at directly through the megameter, of which the focus has not been changed. The image once measured, it only remains to divide it by the size of the object in order to have the amplification.

The *camera lucida* and the process of *double vision* ("double vue") also give the means of measuring the amplification, because the eye is a pretty good judge of the distance of images, and consequently of their size, when it can compare them to different objects whose place is exactly determined (pencil, paper, divided scale, &c.). In having recourse to these processes of measurement, we recognize that instruments with *virtual* images give all the amplifications possible, from a minimum up to infinity, each corresponding to a different distance of the image.

It is therefore inexact to say that such and such a lens, or Microscope, magnifies the image of objects a certain number of times, unless we add at what distance such an image ought to be for the indicated amplification to be realized.

The magnifying power of different instruments could be exactly defined, by measuring for each of them the amplification produced at a fixed distance—a decimetre, for example—because all other amplifications could be deduced from that, with sufficient exactitude, by a simple proportion.

What has led to the supposition that virtual images (in the Microscope especially) were constantly referred to the same distance (the distance of distinct vision), is probably the fact that, in spite of the enormous variation of distance and size, which virtual images, given by optical instruments, undergo, they always subtend in the eye nearly the same angle,† do not vary sensibly in brilliancy, neither lose nor

* See, on the measurement of magnifying powers and the use of the megameter, 'Monitore toscano,' 20 August, 1861; 'Memorie della R. Accademia delle Scienze di Torino,' vol. xxiii. pp. 455-465; 'Nuovo Cimento,' vol. xvii. p. 177.

† The method employed by astronomers to measure the amplification, gives accurate results, in consequence of the almost absolute invariability of the angle subtended by the image.

gain in any of their details, and seem consequently not to move in space. In Microscopes of high magnifying power, the tenuity of the pencils of rays which start from every point of the image also contributes to make its position in space uncertain to the eye, since the accommodation is no longer necessary in order to see it tolerably clearly. However, it none the less exists in a definite place in space, where we must go to measure it in order to know the true amplification; and here again the *megameter* can be employed with advantage.

Discosporangium, a new genus of Phæosporeæ.—The fact that the majority of Phæosporeæ are only to be met with during a portion of the year, led M. Falkenberg (at the Naples Zoological Station) * to the conjecture that they may at certain periods withdraw themselves to great sea-depths. Although this conjecture was not confirmed, it led to the discovery of a new genus at a depth of 15 metres, off Cape Misenum. This sea-weed, to which Falkenberg gives the name *Discosporangium subtile*, consists of filaments of cells growing by an apical cell. They have lateral branches, springing from the middle of the cells of the filament. The origin of the sporangia (zoosporangia) is the same. They are placed solitary at the centre of the cells, and form a unilamellar square plate, the compartments of which open, when ripe, on the upper side of the sporangium. The further development of the zoospores was not observed. The author suggests that the zoospores produced in unilocular and plurilocular sporangia of the Phæosporeæ perform different functions. Although the systematic position of *Discosporangium* is still doubtful, Falkenberg considers its nearest ally to be *Choristocarpus*, a genus separated from the Ectocarpeæ by the mode of development of the thallus. In the course of his researches the author had the opportunity of confirming the observations of Sirodot on the genetic connection of *Chantransia* and *Batrachospermum*. He also gives a list of a considerable number of species of marine Florideæ which bear on the same individual both tetraspores and capsular fruits, as, for instance, species of *Callithamnion* and *Polysiphonia*.

Reproduction of Ulvaceæ.—The reproduction of three species, *Monostroma bullosum*, *Tetraspora lubrica*, and *Ulva rigida* has been studied by J. Reinke.† In the first-named species he observed the formation and conjugation of the zoospores, the development of the resulting zygospore into a resting spore, and the subsequent conversion of the latter, by division of its contents, into a young *Monostroma* thallus. The non-sexual reproduction of the plant was also observed.

The observations on *Ulva rigida* showed that in this species also new individuals are produced from resting spores without the intermediate formation of zoospores.

In *Tetraspora lubrica* the macrozoospores, after a short free existence, settle down and divide into four, the daughter-cells being either all in one plane, or arranged tetrahedrally. Multiplication

* 'Mittheilungen der Zoologischen Station zu Neapel,' vol. i. (1878) p. 54.

† 'Jahrb. f. wiss. Bot.,' vol. xi. (1878) p. 531.

of these cells begins and continues, in the first case, in one plane, in the second radially. Usually several macrospores come to rest together, and then the young thalli formed from them fuse together into a single irregular mass. The formation of microzoospores was also observed, and their conjugation; the resulting zygosporc grew to the size of a macrospore, and then divided in the same way as the latter.

Nostoc-colonies in Anthocerotæ.—The colonies of parasitic *Nostoc* occurring in the thallus of various species of *Anthocerotæ* were investigated some years since by Janczewski, and have now been studied again by Leitgeb.* He finds that the motile filaments of the parasites penetrate through the young stomata, the air-cavities in connection with them being then filled with mucilage. Sometimes, however, infection seems to be brought about by a few isolated *Nostoc*-cells, or even by a single cell. It is probable that there is more than one species of *Nostoc* inhabiting the different genera of *Anthocerotæ*, but this is not certain.

For further details we must refer our readers to the paper itself. It is illustrated by one plate, showing the formation of the stomata and air-cavities, and the relation of the *Nostoc*-colonies to them.

Support for the Head in Drawing with the Camera Lucida.—A writer in 'Science-Gossip'† points out the assistance which the draughtsman will receive by keeping the head steady as well as the hand, and explains a device he has made use of for this purpose. It consists simply of two upright brass rods with a flat sliding cross-bar (covered with some soft substance) between them, which can be screwed tight at any height, and on which the forehead is placed in the position desired.

Alcoholic Fermentation.—The 'Comptes Rendus' have continued to contain further "observations" and "replies" on the discussion raised between M. Pasteur and M. Berthelot in regard to the posthumous MSS. of the late Claude Bernard. We noticed at p. 270 of vol. i. the commencement of the controversy, and at p. 82 of this volume M. Pasteur's refutation of M. Bernard's views. This was criticised by M. Berthelot,‡ who maintained his original view, that the action of ferments is reducible to purely chemical conditions independent of life; to whom M. Pasteur again replied,§ charging M. Berthelot with putting forward entirely gratuitous hypotheses which have never been supported by any personal observations. He thus describes the hypotheses:—1st. In alcoholic fermentation there is perhaps produced a soluble alcoholic ferment. 2nd. This soluble ferment perhaps consumes itself in proportion to its production. 3rd. There are perhaps conditions in which this hypothetical ferment would be produced in greater proportion than the amount destroyed. M. Pasteur deals seriatim with M. Berthelot's objections, and says that if he will endeavour to support his hypotheses by experiments,

* 'Sitzungsb. k. Wiener Akad. du Wiss.,' vol. lxxvii. (1878) p. 411.

† 'Hardwicke's Science-Gossip,' No. 170 (1879) p. 32.

‡ 'Comptes Rendus,' vol. lxxxvii. (1878) p. 949.

§ Ibid., p. 1053.

and should discover a soluble alcoholic ferment, he (M. Pasteur) would applaud his discovery, which would be very interesting, and not in any way annoying. If he should arrive at conclusions contrary to the principles established by M. Pasteur, the latter assures him that "he would hasten to do for those conclusions what he has done for Bernard's, viz. demonstrate their fallacies," and he calls upon M. Berthelot to controvert his statements, not by *a priori* theories, but by serious facts.

On this reply M. Trécul made some observations* tending to charge M. Pasteur with holding contradictory opinions in stating that he adhered to his original classification of microbia into aerobic or azymic, and anaerobic or zymic, while at the same time founding a third class, which, according to circumstances, have the property of living in air or without oxygen. M. Pasteur contented himself with saying that M. Trécul's memory was at fault, and that since 1861 he has always maintained the existence of the three kinds of organisms.

Another "Reply to M. Pasteur" from M. Berthelot was read on the 6th January,† in which, after some preliminary remarks, he "comes to the question of the organisms which borrow from the sugar, according to M. Pasteur, combined oxygen in place of the free oxygen with which the air provides them in the ordinary conditions of their existence." He retorts upon M. Pasteur the absence of any support from "serious facts," and asserts that, on the contrary, serious, positive facts prove that the "nutrition of yeast results from a complex ensemble of chemical transformations, an ensemble which it would be dangerous to the progress of science to simplify by the apparent clearness of a pure supposition founded on a physiological antithesis. A sufficient number of valuable discoveries have established the reputation of M. Pasteur, so that he can give up without detriment a theory so little justified by facts."

M. Trécul subsequently laid before the Academy‡ a detailed paper, in which he endeavoured to establish his assertions by numerous extracts from M. Pasteur's writings. M. Trécul considers:—

1st. That the organized ferments are only particular states of more or less complicated species, which are modified according to the media in which they are.

2nd. That in place of establishing three classes of inferior organisms, as M. Pasteur proposes, there is really only one, each species being able to present one or many aerobian states, and one or many anaerobian states.

The activity of the subsequent controversy may be judged of by a reference to our "Bibliography," where will be found the list of the "Replies," "Second Replies," "Third Replies," "Fourth Replies," "Last Replies," and further "Observations," and "Notes" of MM. Pasteur, Berthelot, and Trécul, with which the subsequent numbers of the 'Comptes Rendus' abound.

The discussion between M. Pasteur and M. Trécul was closed by

* 'Comptes Rendus,' vol. lxxxvii. p. 1058.

† Ibid., vol. lxxxviii. (1879) p. 18.

‡ Ibid., p. 51.

the following "reply" of the former: *—"Ma classification est ce qu'elle est. Acceptez-la ou rejetez-la, cela vous regarde. Pour moi elle est excellente!"

Bacteria in the Poison of Serpents.—M. Lacerda calls the attention of the French Academy to a fact he observed at the physiological laboratory at Rio de Janeiro.

Contrary to the general belief that the venomous matter is nothing but a poisonous saliva acting like *soluble ferments*, he observed facts which prove, in his opinion, that it contains *figured ferments*, whose analogy with bacteria was remarkable. Subjecting a snake to chloroform, he extracted from it a drop of its poison on a glass plate, previously washed in alcohol and slightly warmed. Immediately placing it under the Microscope, a kind of protoplasmic filamentous matter was seen, formed of an aggregation of cells, arranged in an arborescent form like certain *Lycopodiaceæ*.

Gradually the filament (enlarged where the spores are) is dissolved and disappears, and the spores are set at liberty, assuming a linear arrangement. Then, if the conditions of the surrounding medium are favourable to their development, they swell and enlarge sensibly, pushing out, after a time, a kind of small tube, which quickly lengthens. This soon separates, and forms another spore, which is reproduced in the same way.

When these spores have attained a certain size, a filament is observed in their interior, which becomes more and more marked, and presents here and there ovoid and very refractive corpuscles; in a short time the protoplasm of the spore is retracted, its membrane is dissolved, and the corpuscles are set at liberty to continue afterwards the same process of reproduction.

The spores have, however, two principal modes of multiplication—by scission and by internal nuclei. In the blood of animals killed by the bite, the following phenomena were observed:—

The red globules began by showing small brilliant points on the surface of the disk, which sometimes formed projections and became more and more numerous. By following attentively the different phases of the change, he succeeded in seeing the globule completely destroyed, and replaced by numerous ovoid very brilliant corpuscles, endowed with spontaneous oscillatory movement. Sometimes they were not disengaged from the globular mass, but remained enclosed within it, and the globules became fused with each other, forming a sort of amorphous very diffuent paste.

The animals in which a hypodermic injection was made of the blood, immediately after the death of the animal bitten, all died in a few hours, with almost the same symptoms, and their blood always showed the same changes remarked in animals directly poisoned.

M. Lacerda also ascertained that alcohol injected under the skin, or introduced through the mouth, is the real antidote against this ferment.

In presenting this paper, M. de Quatrefages added that in his

* 'Comptes Rendus,' vol. lxxxvii. p. 255.

opinion it was necessary to make "serious reserves as to the conclusions of the author."

Flagellated Organisms in Rats' Blood.—In the 'Fourteenth Annual Report of the Sanitary Commissioner with the Government of India' is a paper on "the Microscopic Organisms found in the Blood of Man and Animals," by Mr. T. R. Lewis, M.B., in which he disputes the correctness of what he terms one of the fundamental tenets of M. Pasteur's creed, viz. that neither microscopic organisms nor their germs are ever found in the blood of an animal in health.

In July, 1877, he detected organisms in the blood of a rat which he was examining. Under the Microscope, the blood appeared to quiver with life, and on diluting it with a half per cent. solution of salt, motile filaments could be seen rushing through the serum, and tossing the blood-corpuscles about in all directions. Their movements were of a more undulatory character than spirilla, and the filaments were thicker, more of a vibrionic aspect. They were pale translucent beings, without any trace of visible structure or granularity. It was observed that every now and then blood-corpuscles some considerable distance from any visible motile filament would suddenly quiver. On carefully arranging the light, it was seen that this was due to a very long and exceedingly fine (apparently posterior) flagellum. These hæmatozoa may sometimes be kept alive for two or three days, but generally die and disappear from view within twelve or twenty-four hours, as though they had been dissolved in the serum in which they were found. They may be preserved by spreading out a thin layer of the blood containing them over a thin covering glass, and inverting it over a weak solution of osmic acid. The preparation should be removed as soon as it presents a dry, glazed appearance, and may be thus mounted in the dried condition, or in a saturated solution of acetate of potash. The flagellum cannot be detected in such a preparation; apparently the refractive index of the substance forming the flagellum and that of the serum approximates so closely, that it can only be detected when creating a current by its movements.

The body-portion may be measured after they have been killed by means of osmic acid. The width of the anterior half or body-portion averages $\cdot 8$ to $1\ \mu$, or precisely that of ordinary blood-bacilli, and its length from 20 to 30 μ . The flagellum, so much of it as is visible, is somewhat of the same length, though possibly considerably longer, as the slope from the body-portion is very gradual; and when the eye follows it to the bounds of visibility, an impression is conveyed that there may be still more of it.

On applying electricity to a drop of the blood, it was found that an interrupted current of such a strength as could not be comfortably borne by an individual was tolerated by these beings for several consecutive hours.

The species of rats in which these organisms were found were *Mus decumanus* and *M. rufescens*. They were never found in mice.*

* 'Quart. Journ. Mic. Sci.,' N. S., vol. xix. (1879) p. 109.

Deceptive Appearances produced by Reagents.—A paper recently communicated by Dr. George Thin to the Royal Society * under this title, was intended, in addition to being a contribution to the histology of hyaline cartilage, to illustrate how much the apparent structure of a tissue which is being examined microscopically depends on methods of preparation.

In the examination of a cartilaginous tumour of the lower jaw, the author was able to isolate the cells from the cartilaginous substance of the tumour after the action of osmic acid. All the cells observed were flattened, rounded, or somewhat polygonal bodies, with round nuclei. Their contours did not correspond exactly with those of the rounded cartilage “capsules” in which they lay.

The examination of this tumour showed that most delusive appearances as regards the nature of cartilage cells may be sometimes produced by staining and hardening agents. Carmine and eosin, by staining an unformed substance that exists in the structure in defined tracts, may simulate branched protoplasmic cells, and bichromate and logwood preparations, either in sections or teased out, may as closely simulate cells with fibre processes.

These facts justify, the author considers, serious doubts as to the correctness of interpretation in all cases in which histologists have described branched cells in hyaline cartilage, whether the latter existed as a normal structure or as a pathological growth. They further show that, taken alone, carmine or eosin-staining should not be held as conclusive evidence of the existence or limits of cellular protoplasm in any animal tissue.

Preparation of Red Blood-corpuscles.—Very excellent permanent preparations of the red blood-corpuscles of Amphibia may be made by Ranvier's method, as follows:—Some blood is allowed to drop from a wound into about two hundred times its volume of a saturated picric acid solution. After a few minutes the picric acid is carefully poured off, leaving most of the corpuscles at the bottom of the dish; a solution of picro-carmine is then poured over them, and allowed to stand a day or two. The picro-carmine is then poured off, and the sediment put into acid glycerin (glycerin 100 parts, acetic acid 1 part). The corpuscles so treated will last a long time, and may be mounted in the acid glycerin at any time. The nuclei of the corpuscles are stained bright red, and the body light yellow. Corpuscles of *Menobranthus*, which are about twice as large as those of the frog, prepared in this way nearly a year ago, appear perfect as ever.

Apparatus for Determining the Angle of the Optic Axes of Crystals with the Microscope.—Professor A. de Lasaulx, referring to a previous paper,† in which he described a method he had devised for this object, says that it often presents difficulties, as it supposes

* ‘Proc. Roy. Soc.,’ vol. xxviii. (1878) p. 257.

† Mr. S. H. Gage, in ‘Amer. Quart. Mic. Journ.,’ vol. i. (1879) p. 160.

‡ ‘Bulletin de la Société Belge de Microscopie,’ vol. iv. (1878) p. 177, noticed in part in this Journal, vol. i. p. 207.

that we have two thin plates of the mineral to be examined, cut perpendicularly to one another. In the case of all minerals whose cleavage in one direction is very perfect, it is difficult, and often even impossible, to cut a thin plate normal to the direction of the cleavage. It was, therefore, desirable to be able to determine the apparent angle of the optic axes by direct measurement with the Microscope. In all cases where a mineral only becomes transparent when the plates are very thin, the determination of the angle of the optic axes can only be effected in general with the Microscope.

To arrive at this result, the distance of the poles of the optic axes of a mineral, as seen in the interference image, must be compared with this same distance in a film of biaxial mica, for which the angle of the optic axes has been determined by an instrument specially designed to measure it.

To make a sufficiently exact comparison of the distances of the poles in the film of mica, and in the thin plate of the mineral to be examined, we must be able to measure exactly these two distances in the Microscope. As the eye-piece is removed in order to see the interference image, the eye-piece micrometer cannot be used without employing lenses by which the interference image is distorted.

The following form of apparatus has accordingly been designed by Professor de Lasaulx. On the edge of the setting of the upper Nicol, a brass cover A (Fig. 1) is fixed by screws *d*, having a diaphragm of

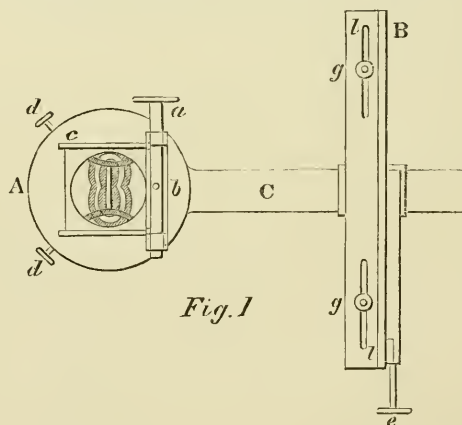


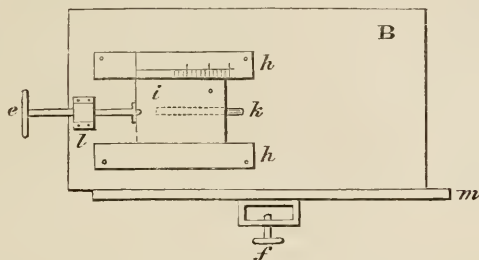
Fig. 1

the same size as the glass which covers the Nicol. At one side there is a horizontal axis which can be turned by the screw *a*, and at the same time this axis and the plate which it supports can be turned round a screw *b*. This axis holds an ordinary covering glass *c*, through which may be seen the image in the Microscope. A rod *C* carries the other part of the apparatus *B*, which consists of a blackened rectangular screen with a very fine horizontal slit *k* (Fig. 2) in the middle. On one side the screen has a small slide *i*, which by the screw *e* passing through *l*, may be moved in the grooves *h* to the right or to the left,

and the slit opened or shut. One of the grooves has a graduated scale, by which the length of the open slit is shown.

The apparatus is fixed on the Microscope in such a way that the slit in the screen is illuminated by the light of the window. If the glass c

Fig. 2



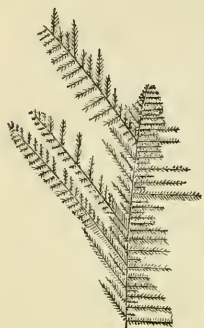
is then raised to an angle of 45° with the horizon, no difficulty will be experienced in seeing a reflected image of the slit *k* on the glass, in the middle of the diaphragm of A. Hence, looking through the glass into the Microscope, we see simultaneously the interference image and the reflected image of the slit, which appears as a brilliant line. It now remains to bring one of the two extremities of the image of the slit over one of the visible poles of the optic axes. That this may be done, the screen B is movable on the plate *m*, which serves as its base, and with which it is fixed by the screw *f* on the rod C; the two screws *g* are inserted in the oblong openings *l*, and by loosening these screws a little the screen can be moved upon the base-plate to the right or to the left, so that the desired position may be obtained. By opening the slit we can make the other end of its image coincide with the pole of the other optic axis in the interference image. This position is represented in Fig. 1.

The scale shows the length of the opening of the slit, and the distance of the poles of the optic axes. Measuring by the same method the distance of the poles for mica, of which the apparent angle of the optic axes is known, the proportion is found of the two distances, which enables us to calculate easily the angle of the optic axes. The scale is carefully graduated in fifths of a millimetre, and with the help of a lens the third of a degree can easily be distinguished, and the error in the results is found not to exceed one or two degrees.

It will be understood that this method is only applicable to minerals in which the angle of the optic axes is not large, or the poles of the axes would be no longer visible. But it is easy to put the preparation in a small cup of oil, and then measure the angle in the oil.

Artificial Crystals of Gold.—A few years ago some objects from America were exhibited which, under a power of 150 to 200, looked like microscopic fern-leaves gilt (see woodcut), but which were stated to be crystals of gold. The process by which they were produced was

not disclosed, and several ineffectual attempts were made to reproduce them. The following is stated to be the method of manufacture: *—



A solution of chloride of gold and ammonium is placed in a shallow dish coated with heavy gold foil, which is connected with the zinc plate of a large Daniell's battery. Near the top of the solution, and connected with the copper plate of the battery, a roll, made up of thin strips of pure gold, is suspended, enclosed in a muslin bag. The strength of the battery current is controlled by a coil of wire arranged as a rheostat, a clamp terminating one of the battery wires enabling the operator to include a greater or less number of coils in the circuit. The necessary conditions being fulfilled, on completing the circuit the gold is gradually dissolved from the roll and deposited on the bottom of the dish in bright crystalline

flakes, having the appearance of feathers or fern-leaves when examined under the Microscope.

The Vertical Illuminator.—This illuminator was originally intended to be used in conjunction with medium-power dry objectives, of moderate angles, such as were formerly so much in vogue. Mr. Morehouse, a well-known microscopist of Wayland, New York, has found that by the conjoint use of the illuminator with immersion objectives of high balsam apertures, astonishing results may be secured; as, for instance, the resolution of the markings of *Podura* and other insect scales, the striation of valves of *Frustulia Saxonica*, *Surirella gemma*, and similar "difficult" diatoms, under amplifications of 3000 and 4000 diameters, and, as a matter of course, by reflected light.

Dr. Edward Smith has devised a modification,† consisting of an adjustable shutter, regulating the admission of light, thus greatly improving the brilliancy of the objects, accompanied with marked increase of resolving power; and with the instrument thus modified he had no difficulty in obtaining beautiful displays of the Nobert 19th band, the simultaneous exhibition of the long and transverse striæ of *Frustulia Saxonica*, &c., under powers of 3000 and 4000 diameters.

Desiring to test it on histological preparations, he thus examined a slide of human blood, improvised for the occasion, and was astonished to find about three-fourths of the red corpuscles nucleated. The amplification employed in these observations was about 3700 diameters.

A point which should not be lost sight of is that the vertical illuminator can only be successfully used in conjunction with an objective of high balsam angle.

* Mr. A. H. Chester, in 'Amer. Journ. of Sci. and Arts,' 3rd ser., vol. xvi. (1878) p. 29.

† 'American Naturalist,' vol. xiii. (1879) p. 137.

Reproduction of Noctiluca.— At p. 331 of vol. i. we quoted from 'Comptes Rendus' a paper by Professor Ch. Robin on this subject. The further detailed memoir there mentioned is published in the author's 'Journal de l'Anatomie et de la Physiologie,'* where, besides the greater completeness of the text (67 pp.), it has the advantage of being accompanied by seven plates.

* 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. xiv. p. 563

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On *Loxosoma* and *Triticella*, Genera of Semiparasitic Polyzoa in the British Seas. Rev. A. M. Norman, M.A.

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! On the Asteroidea and Echinoidea of the Korean Seas. W. Percy Sladen, F.L.S., F.G.S. (1 plate.)

On some Ophiuroidea from the Korean Seas. Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., &c. (3 plates.)

The Anniversary Address of the President, Prof. Allman, M.D., LL.D., F.R.S.—Recent Progress in our Knowledge of the Structure and Development of the Phylactolæmatous Polyzoa.

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On *Mycoidea parasitica*, a new Genus of parasitic Algæ, and the part which it plays in the formation of certain Lichens. D. D. Cunningham, M.B., F.L.S., Surgeon H.M. Indian Army. (2 plates.)

On the occurrence of Conidial Fructification in the *Mucorini*, illustrated by *Choanephora*. By the same author. (1 plate.)

On the Self-fertilization of Plants. Rev. George Henslow, M.A., F.L.S., F.G.S. (1 plate.)

List of Fungi from Brisbane, Queensland, with Descriptions of New Species. Rev. M. J. Berkeley, M.A., F.L.S., and C. E. Broome, F.L.S. (2 plates.)

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Recent Researches into the Origin and Development of Minute and Lowly Forms of Life, with a glance at the bearing of these upon the origin of Bacteria. Rev. W. H. Dallinger, F.R.M.S.

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Researches on the Department and Vital Resistance of Putrefactive and Infective Organisms from a physical point of view. Prof. Tyndall, LL.D., D.C.L., F.R.S.

Part 5, No. 68 (April, 1878). (Nil.)

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On the Influence of Light upon Protoplasm. Arthur Downes, M.D., and Thomas P. Blunt, M.A. Oxon.

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Report on Phyto-Palæontological Investigations generally, and on those relating to the Eocene Flora of Great Britain in particular. Dr. Constantin Baron Eittinghausen, Professor in the University of Graz, Austria.

No. 192 :—

On some Points connected with the Anatomy of the Skin. George Thin, M.D. (1 plate and 4 figs.)

On Hyaline Cartilage, and Deceptive Appearances produced by Reagents, as observed in the Examination of a Cartilaginous Tumour of the Lower Jaw. George Thin, M.D. (5 figs. of a plate.)

On the Effect of strong Induction-Currents upon the Structure of the Spinal Cord. W. M. Ord, M.D., F.L.S., Fellow of the Roy. Coll. of Physicians, Physician to St. Thomas's Hospital.

Concluding Observations on the Locomotor System of Medusæ. George J. Romanes, M.A., F.L.S.

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On the Mechanism of the Odontophore in certain Mollusca. Patrick Geddes. (3 plates.)

Scotland.

SCOTTISH NATURALIST, Vol. V., No. 33 (January, 1879):—

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Description of new Scottish Lichens. J. Stirton.

Report of Cryptogamic Society's Exhibition of Fungi, 1878. Rev. J. Stevenson.

Ireland.

PROCEEDINGS OF THE ROYAL IRISH ACADEMY, Vol. III., Ser. II., No. 2 (November):—

On Hullite—a hitherto undescribed Mineral, &c. Edward T. Hardman, F.C.S., H.M. Geol. Survey. With Notes on the Microscopical Appearances, by Prof. E. Hull, M.A., F.R.S.

TRANSACTIONS OF THE ROYAL IRISH ACADEMY, Vol. XXVI. (Science), No. 17 (October):—

Report on the Acanthology of the Desmosticha (Haeckel). Part I. On the Acanthological Relations of the Desmosticha. H. W. Mackintosh, B.A., Senior Mod. in Nat. Sc., T.C.D. (3 plates.)

Australian Colonies.

PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES, Vol. II., Parts 3 and 4 (issued 1878):—

On some Australian Shells, described by Dr. A. Gould. Rev. J. E. Tenison-Woods, F.G.S., &c., &c.

On some new Marine Shells. By the same author.

Descriptions of three new Species of *Helix* from South Australia. Prof. Ralph Tate.

On the Extra-tropical Corals of Australia. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c., &c. (3 plates.)

On the Echini of Australia (Supplemental Note). By the same author.

Continuation of the Mollusca of the Chevat Expedition. J. Brazier, C.M.Z.S., Corr. Memb. Roy. Soc., Tas.

Notes and Remarks on Mollusca recently found in Port Jackson and New Caledonia. By the same author.

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On an Australian variety of *Neritina pulligera*, Linn. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c.

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On a new Species of *Psammoseris*. By the same author. (1 plate.)

On a new Species of *Desmophyllum* (*D. quinarium*), and a young stage of *Cycloseris sinensis*. By the same author.

On some Australian Littorinidæ. By the same author.

On the Power of Locomotion in the Tunicata. William Macleay, F.L.S.

JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES, 1877, Vol. XI. (issued 1878):—

On some new Australian Polyzoa. Rev. J. E. Tenison-Woods, F.G.S.; Hon. Memb. R. S. N.S.W., &c., &c. (2 woodcuts.)

On some Australian Tertiary Corals. By the same author.

A Synopsis of the known species of Australian Tertiary Polyzoa. R. Etheridge, jun., F.G.S., &c.

Reports from the Sections (in Abstract).—Section E. Microscopical Science.—Reports of Proceedings of May–Nov. Meetings.

Remarks on the Coccus of the Cape Mulberry. F. Milford, M.D., M.R.C.S., &c.

Notes on some Local Species of Diatomaceæ. G. D. Hirst.

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On some new Marine Mollusca. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c.

On the History of Palæozoic Actinology in Australia. R. Etheridge, jun., F.G.S.

United States.

AMERICAN JOURNAL OF MICROSCOPY, Vol. III., No. 12 (December):—

What can be done with a Cheap Microscope. (From 'Young Scientist.')

The Microscope in Medicine. Dr. S. M. Mouser.

The Use of the Microscope. Geo. E. Blackham, M.D. (From 'Cincinnati Medical News.')

The Microscopical Examination of Yeast popularly explained. (From 'London Brewers' Journal.')

Outlines of a Process for the Examination of Urine for Medical Purposes. Arranged by R. Hitchcock.

On Biotite as a Pseudomorph after Olivine. Prof. A. A. Julien.

Recent Progress in the Study of the Lower Order of Cryptogams (Sir Joseph Hooker's Presidential Address, R. S.).

Exclusive Publication of Society's 'Proceedings.'

The Micrometric Standard.

Review of King's 'Urological Dictionary.'

Melting Point of Fats.

Vol. IV., No. 1 (January):—

Structure of Coloured Blood-corpuscles. (Paper read before the 'New York Academy of Sciences,' by Prof. Elsberg, M.D.) (1 plate.)

Artificial Crystals of Gold and Silver. Albert H. Chester. (5 woodcuts.)

Trichinae in Pork. (Report of Mr. Atwood and Dr. Belfield to Office Health Depart., Chicago.)

The Microscope in Medical Jurisprudence. (Paper read by President H. C. Hyde before the 'San Francisco Microscopical Society.')

Notes on Diatomaceæ from Santa Monica, California. (Paper by Mr. Chas. Stodder, read before the same Society.)

Microscopic Soirées.—An improved Method of exhibiting Objects. Geo. E. Fell.

A new Form of Collecting Cane. (1 woodcut.)

Microscopic Pond Life. (Paper read before the North Staffordshire (Eng.) Naturalists' Field Club, by Mr. T. S. Wilkins.)

Transactions of Societies.—San Francisco Microscopical Society, Nov. 7 and 21. —Microscopical Section, Troy Scientific Association (no date).—Buffalo Microscopical Club (Nov. 10 and 11).

Exchanges.

A new Rotifer. D. S. Kellicott. (1 woodcut.)

Volvox globator. (From 'Young Scientist.') (1 woodcut.)

Sizes of Gun Punches.

Tolles' $\frac{7}{8}$ Objective.

Trichina.

Transactions of Societies.—San Francisco Microscopical Society, Dec. 5 and 19.—Buffalo Microscopical Club, Jan. 14.

Exchanges.

AMERICAN JOURNAL OF SCIENCE AND ARTS, Third Series, Vol. XVII., No. 97 (January):—

Scientific Intelligence.—Botany and Zoology:—'Die Algen Flora des Weissen Meeres.' By Dr. C. Gobi.—'North American Fungi: Fungi Americani, Centuries I. and II.' By H. W. Ravenel and M. C. Cooke.—'North American Fungi.' By J. B. Ellis.—'The Early Types of Insects.' By S. H. Scudler.

No. 98 (February):—

Scientific Intelligence.—Botany:—Botanical Neerology of 1878—E. M. Fries (Upsal); L. Pfeiffer (Cassel); A. Murray (Edinburgh); A. Bloxam (England); F. V. Raspail (Paris); S. Kurz (Calcutta); M. Durieu (Bordeaux); C. Pickering (Boston, U.S.); M. Seubert (Carlsruhe); T. Thomson (England); G. Zanardini (Venice); R. de Visiani (Padua); B. C. Du Mortier.

AMERICAN NATURALIST, Vol. XIII., No. 1 (January):—

On certain Contrivances for Cross-Fertilization in Flowers. By Prof. J. E. Todd. (8 woodcuts.)

The Gemmule v. the Plastidule as the ultimate Physical Unit of Living Matter. J. A. Ryder.

Absorption of Water by the Leaves of Plants. A. W. Bennett, M.A., B.S., F.L.S.

Recent Literature.—Sars' Molluscan Fauna of Arctic Norway (W. H. Dall).—Packard's Guide to the Study of Insects.—Thomas's Noxious Insects of Illinois.

General Notes.—Zoology:—Amphioxus and Lingula at the Mouth of Chesapeake Bay.—Singular Habit of a Meloid Beetle (S. W. Williston).—New Cincinnatiological Papers.—Collett's List of Norwegian Zoological Literature for 1877.

Microscopy.—Removal of Air from Microscopic Specimens (F. C. Clark).—Limits of Accuracy in Measurements with the Microscope (W. A. Rogers, from a paper read at the Nat. Micr. Congress).—The Society Screw.—Exchanges.

No. 2 (February):—

Instinct and Reason. F. C. Clark, M.D.

Recent Literature.—Brehm's Animal Life. (11 plates.)

Moseley's Structure of the Stylasteridae.

General Notes.—Zoology:—A Gall-inhabiting Ant (W. H. Patton).—A Hummer's Meal (W. H. Ballou).—Recent Papers on Crustacea (J. S. Kingsley).—The Nebaliad Crustacea as Types of a new Order (A. S. Packard, jun.).

Microscopy.—Nucleated Red Corpuscles of Human Blood (J. Edwards Smith).—The Wenham Compressorium.—Exchanges.

No. 3 (March):—

Remarks on Fossil Shells from the Colorado Desert. R. E. C. Stearns. (12 woodcuts.)

Experiments with *Pyrethrum roscum* in killing Insects. W. L. Carpenter, U.S.A.

Recent Literature.—Gegenbaur's Elements of Comparative Anatomy.—Schmarda's Zoology.

Botany.—*Aspidium bootii*.

Geology and Palaeontology.—The Nature of Eozoon.

Microscopy.—New Microscopical Societies.—American Quarterly Microscopical Journal.—Sale of a Microscopical Library.—Spring Clips.

AMERICAN QUARTERLY MICROSCOPICAL JOURNAL, Vol. I., No. 2 (January):—

New Rhizopods. Prof. W. S. Barnard, B.S., Ph.D. (1 plate.)

A Study of one of the Distomes. C. H. Stowell, M.D. (1 plate.)

On the probable Error of Micrometric Measurements. Edward W. Morley, M.D., Ph.D.

Standard Measures of Length. Prof. W. A. Rogers.

On the Fissure-Inclusions in the Fibrolitic Gneiss of New Rochelle. Alexis A. Julien. (1 plate and 1 woodcut.)

The Classification of the Algae. Rev. A. B. Hervey, A.M. (1 plate.)

The Ampulla of Vater, and the Pancreatic Ducts in the Domestic Cat. Simon H. Gage, B.S. (1 plate.)

Practical Hints in Preparing and Mounting Animal Tissues. Carl Seiler, M.D. (2 woodcuts.)

Observations on several Forms of Saprolegniace (concluded). Frank B. Hine, B.S. Classification of the simplest Forms of Life. B. Eyferth.

Editorial.

Microscopic Vision.—Yellow Fever.—A Letter from Professor Abbe.—Notes.—

Laboratory Notes and Queries (by S. H. Gage).—Digest of current Literature.
 —Microscopical Societies.—Book Notices.—Publications received.
Transactions of the New York Microscopical Society (January, 1879).
 Mechanism by which *Echinorhynchus* anchors his Snout. J. D. Hyatt.
 Euglena and Trachelomonas. R. Hitchcock.
 Proceedings of Meetings of 4th Oct. and 1st and 13th Nov., 1878.

France.

ANNALES DES SCIENCES NATURELLES (BOTANIQUE), Sixth Series, Vol. VII., Nos. 1 and 2 (issued February, 1879):—

Researches on the Depazeæ. L. Crié. (8 plates.)
 Studies on the Seminal Integuments of the Gymnospermous Phanerogams. C. E. Bertrand (6 plates to follow.)
 Observations on the Modifications of Plants according to the physical conditions of the medium. G. Bonnier and Ch. Flahault.

BRÉBISSONIA, —illustrated Monthly Review of Algology and Botanical Micrography. Edited by M. G. Huberson. Vol. I., No. 7 (January):

Spirogyra Lutetiana, n. sp., P. Petit. P. Petit. (1 plate.)
 Some Remarks on the Diatomaceæ of P. T. Cleve and Möller. Upsal, 1878. Nos. 1–48. A. Grunow. (From 'Amer. Journ. of Microscopy'.)
 Diseases of Plants caused by *Peronospora*, &c. Disease of Lettuces called "Le Meunier." (Both by Max Cornu and from 'Comptes Rendus'.)
 Organization of *Hygrocrocis arsenicus*, Bréb. (By Prof. L. Marchand, from 'Comptes Rendus'.)
Bibliography.—The Thallus of the Diatomaceæ. Dr. M. Lanzi.—*Ædogonia* Americaneæ of V. B. Wittrock. *News*.

JOURNAL DE L'ANATOMIE ET DE LA PHYSIOLOGIE DE L'HOMME ET DES ANIMAUX, Vol. XV., No. 1 (January and February):—

Embryogeny of *Asteriscus verruculatus*. Dr. J. Barrois. (2 plates.)
 Evolution and Structure of the Nuclei of the Elements of the Blood in the Triton. G. Pouchet. (1 plate.)
 Study on the Lymphatics of the Skin. Drs. G. and F. E. Hoggan. (2 plates.)
 Analysis of 'The Absorption of Colouring Matters by the Roots of Plants.' MM. Max Cornu and E. Mer.

No. 2 (March to April):—

The Parasitic Acarians of the Cellular Tissue and Air Reservoirs of Birds. P. Mégnin. (2 plates and 3 woodcuts.)
 Contribution to the Study of the *Retinal Purple*. M. H. Beauregard. (1 plate.)
 On the Employment of Wet Collodion for Microscopic Sections. Mathias Duval.

JOURNAL DE MICROGRAPHIE, Vol. II., No. 9 (September):*—

Revue.—The National Congress of American Microscopists at Indianapolis.—Standard for Micrometric Measurements.—Various American (and Anglo-American) Books on the Microscope, and American Microscopical and other Journals.

Migration of Blood-corpuscles in passive Hyperæmia. Dr. W. T. Belfield. (Read at the Indianapolis Congress.)

A New Field for the Microscopist (*concluded*). W. Saville Kent.

Studies on the Schizomycetes. Oscar Brefeld.

National Micrographical Congress at Indianapolis. Dr. J. Pelletan.

No. 10 (October):*—

Revue.—M. G. Huberson's 'Brébissonia' and 'Practical Formulary of Photography with Silver Salts.'—The 'Zeitschrift für Mikroskopie,' and other German and American Journals.

* For some reason which is unexplained, neither of these numbers were sent to the subscribers in this country, and it was not until No. 11 appeared that the omission was discovered.

The Lymphatic Hearts (*continuation*). Prof. Ranvier. (1 plate.)
Preliminary Note on the Development of the Blood and the Vessels (*conclusion*). Drs. V. Brigidi and A. Tafani.

Volvox globator. A. W. Bennett. (From 'Am. Jour. of Mic.' and 'Pop. Sc. Rev.')

New Oil-Immersion Objective of C. Zeiss, of Jena. W. H. Dallinger. (Taken from 'Nature,' vol. xviii.)

Microscopical Technique.—Preparation of whole Insects without pressure for the Binocular. S. Green. (From 'Jour. Quekett Mic. Club.')

Vol. III., No. 1 (January):—

Revue.—The 'Revue des Sciences Naturelles' of Montpellier.—The 'Recueil de Médecine Vétérinaire.'—The 'Bulletin de la Société Belge de Microscopie,' and American Journals.

The Muscles of the Œsophagus. Prof. Ranvier.

Researches on Spermatogenesis studied in some pulmonate Gasteropoda. Dr. M. Duval. (1 plate.)

Angular Aperture of Microscope Objectives (*continuation*). Dr. G. E. Blackham. (1 plate.)

Diatoms of the Archipelago of the West Indies (*continuation*). Prof. P. T. Cleve. (12 woodcuts.)

Histological Microscope of Mr. C. Collins. (1 woodcut.)

On the Formation of the Spores of the Mesocarpeæ. E. Perceval Wright. (From 'Nature,' vol. xviii.)

Bibliography.—Researches of M. Van Tieghem on the Mucorini. By A. Faure.

No. 2 (February):—

Revue.—Diatoms.—Max Cornu on Peronospora.—'Revue Mycologique.'—The Pasteur-Berthelot Discussion, &c.—This Journal, and other English, American, &c., Journals.

Fecondation in the Vertebrates. Prof. Balbiani.

Angular Aperture of Microscope Objectives (*continued*). Dr. G. E. Blackham. (1 plate.)

Researches on Spermatogenesis studied in some pulmonate Gasteropoda (*conclusion*). Dr. Mathias Duval. (1 plate.)

Method of Studying the Embryo of Fishes. M. F. Henneguy. (From 'Bull. Soc. Phil.' Paris.)

Diatomaceæ of the West Indian Archipelago (*continued*). Dr. P. T. Cleve. (14 woodcuts.)

Note on some Diatoms. F. Kitton. (From 'Bull. de la Soc. Belge de Micr.')

Description of new Species of Diatomaceæ. Prof. H. L. Smith. (From 'Am. Quart. Micr. Journ.')

Reproduction of the Diatomaceæ. (From this Journal.)

Students' Microscope of W. Watson and Son, of London. (1 woodcut.)

Royal Microscopical Society of London.

Cabinet of Microscopy of Arthur C. Cole and Son, of London.

A Letter from Dr. E. Abbe. (From 'Am. Quart. Micr. Journ.')

REVUE MYCOLOGIQUE. (Edited by M. C. Roumeguère.) Vol. I., No. 1 (January):—

Recent Experiences of Dr. Minks.—Lichens are not "Fungi parasitic on Algæ." The Editor.

The Artificial Cultivation of Fungi in Japan. Count de Castillon.

Extraordinary Case of Development of *Bovista gigantea*, Nées, in the environs of Toulouse. The Editor.

Fungorum Novorum Exoticorum Decas. F. de Thümen.

The Myxogastres. Dr. L. Quélet.

The Common Names of the Fungi in the environs of Saintes (Charente-Inférieure). P. Brunaud.

Origin of the Genus *Microsphaeria*, Leveillé. The Editor.

The Preservation of Fungi from a scientific point of view. The Editor.

Microscopic Studies and Preparations of Fungi.—Microscopic Slides of the Rev. J. E. Vize.—Photographic Microscope of Dr. Ch. Fayel. The Editor.
Telephora palmata, Fries. *Forma paradoxa*, Nob. The Editor.
Bibliography.
News.

BULLETIN DE LA SOCIÉTÉ BOTANIQUE DE FRANCE, Vol. XXV.,*
 Parts A.—D.:—

Bibliographical Summary.

Part I. Catalogue of the Marine Diatomaceæ of the Bay of St. Brieuc and of the Coast of the Côtes-du-Nord Department. M. Leuduger-Fortmorel.

The Seat of the Colouring Matters in the Seed (*continuation*). M. J. Poisson.

Note on three new Species of Mosses of New Caledonia belonging to the Genus *Pterobryella*, C. Müll. M. Em. Bescherelle.

COMPTES RENDUS, Vol. LXXXVIII., No. 1 (6th January):—

Reply to M. Pasteur. M. Berthelot.

On a Gigantic Isopod of the Deep Sea. M. Alph. Milne-Edwards.

On the Disease of the Chestnut-trees. M. J. de Seynes.

No. 2 (13th January):—

Do there exist among the lower Organisms species exclusively aërobian and others anaërobian, &c. M. Trécul.

Observations on the Communication of M. Trécul, by M. Pasteur.

Second Reply to M. Berthelot. M. Pasteur.

The Polymorphism of *Agaricus melleus*, Vahl. M. J. E. Planchon.

New Observations on the Development and Metamorphoses of *Tænias*. M. P. Méguin.

No. 3 (20th January):—

Observations on the Second Reply of M. Pasteur. M. Berthelot.

Reply to the Notes of M. Trécul of the 30th December and 13th January.

M. Pasteur.

Reply of M. Trécul.

Observations of M. Pasteur.

On the Special Apparatus of Nutrition of Phanerogamous Parasitic Species.

M. Chatin.

Researches on the Development of Ova and of the Ovary in Mammals, after birth. M. Ch. Rouget.

No. 4 (27th January):—

Third Reply to M. Berthelot. M. Pasteur.

On the Composition of the Banana, and on attempts at utilizing this Fruit.

MM. V. Marciano and A. Muntz.

On the Termination of the Visceral Arterioles of *Arion rufus*. M. S. Jourdain.

Researches on the Physiological Action of *Grenat* or residue of the manufacture of Fuchsine. M. Jousset de Bellesme.

On the Quantity of Light lost in actuating the Visual Apparatus, and its variations under different conditions. M. Charpentier.

On the Phosphorescence of the Flesh of the Lobster. MM. C. Bancel and C. Husson.

No. 5 (3rd February):—

Remarks on the Third Reply of M. Pasteur. M. Berthelot.

On the Fermentation of Cellulose. M. Ph. Van Tieghem.

The Influence of Duration and Intensity on Luminous Perception. MM. Ch. Richet and Ant. Breguet.

The Intimate Structure of the Central Nervous System of Decapod Crustacea.

M. E. Yung.

No. 6 (10th February):—

Last Reply to M. Pasteur. M. Trécul.

Verbal Observations of M. Pasteur.

* The publications of the Society have been interrupted by a printer's strike, but will soon be up to date.

- Reply of M. Trécul to the Observations of M. Pasteur.
 Reply of M. Pasteur.
 Fourth Reply to M. Berthelot. M. Pasteur.
 On the Existence of a Prehensile or Complementary Adherent Apparatus in Parasitic Plants. M. A. Chatin.
 Researches on the Formation of Latex during Germinative Evolution in the Embryo of *Tragopogon porrifolius*. M. E. Faivre.
 Researches on Beer Yeast. MM. P. Schützenberger and A. Destrem.
 On the Banana. M. B. Corenwinder.
 On different Epizootics of Diphtheria of Birds observed at Marseilles, and on the possible Relations of this Disease with the Diphtheria of Man. M. Nicati.
 On the Sensibility of the Eye to the action of Coloured Light more or less combined with White Light, and on the Photometry of Colours. M. A. Charpentier.
 Researches on the Liver of the Cephalopodous Mollusca. M. Jousset de Bellesme.
 Observations on a Rain of Sap. M. Ch. Musset.
 No. 7 (17th February):—
 On the Respiratory Innervation in the Octopus. M. L. Fredericq.
 On the Functions of the Ganglionic Chain in the Decapod Crustaceans. M. E. Yung.
 No. 8 (24th February):—
 On the Composition of Beer Yeast. MM. P. Schützenberger and A. Destrem.
 On the presence of a Segmentary Organ in Endoproct Bryozoa. M. L. Joliet.
 On the Segmentary Organs and the Genital Glands of Sedentary Polychæteous Annelides. M. L. C. E. Cosmovici.
 No. 9 (3rd March):—
 Reply to M. Van Tieghem as to the Origin of Amylobacter. M. A. Trécul.
 Researches on the Foetal Envelopes of the Armadillo with nine Bands. M. Alph. Milne-Edwards.
 Researches on Digestion in Cephalopod Molluscs. M. Jousset de Bellesme.
 Researches on *Peronospora gangliiformis* of Lettuces. MM. Bergeret and H. Moreau.
 On the Influence of Oxygen on Alcoholic Fermentation by Beer Yeast. M. A. Béchamp.
 On a Method of Preserving Infusoria. M. A. Certes.

Belgium.

BULLETINS DE L'ACADÉMIE ROYALE DES SCIENCES, DES LETTRES ET DES BEAUX-ARTS DE BELGIQUE, Second Series, Vol. XLV. (January to June, 1878):—

Researches on the Acinetæ of the Coast of Ostend. Parts 2-4. M. Julien Fraipont. (4 plates.)

Second additions to the Synopsis of the Cordulinæ, and List of those described in the Synopsis and its two additions. M. Edm. de Selys Longchamps.

On a new Species of Crustacea of the Coalfield of Belgium. Dr. L. G. de Koninck; being a translation of a paper, "Discovery of a Species of Brachyuran Decapod in the Coalfield of the environs of Mons," sent by Dr. H. Woodward, F.R.S., F.G.S., F.Z.S. (1 plate and 1 woodcut.)

Researches on the Development of the Inferior Jaw-bone of Man. M. H. Masquelin. (2 plates.)

Contribution to the Physiology of the Vagus Nerve of the Frog. MM. F. Putzeys and A. Swaen.

Researches on the Venomous Apparatus of the Chilopodan Myriapoda; Description of true Poison Glands. M. Jules MacLeod. (1 plate.)

Vol. XLVI. (July to December):—

Discovery of Brachiopoda of the Genus *Lingula*. M. C. Malaise.

Preliminary Communication on the Movements and the Innervation of the Central Organ of Circulation in the Articulated Animals. M. Félix Plateau.

On the Digestion of Albuminoids by some Invertebrata. Dr. Léon Fredericq.
 On a Law of the persistence of Impressions in the Eye. M. J. Plateau.
 * Fourth additions to the Synopsis of the Gomphinae. M. de Selys Longchamps.

Researches on the Structure of the Digestive Apparatus of the *Mygalæ* and the *Nephilæ*. M. Valère Liénard. (1 plate.)

On the Organization and Physiology of the Poulp. Dr. Léon Fredericq.

Reports of MM. Crépín, Gilkinet, and Morren on the two Memoirs—"Bryologia Belgica" and "Belgian Mycological Flora"—sent in response to the fourth question proposed for the Competition of 1878.

MÉMOIRES DE L'ACADÉMIE ROYALE DES SCIENCES, DES LETTRES ET DES BEAUX-ARTS DE BELGIQUE, Vol. XLII:—

Analytical Bibliography of the principal subjective Phenomena of Vision from ancient times to the end of the eighteenth century, followed by a simple Bibliography for the expired part of the present century. M. J. Plateau.

Researches on the Phenomena of Digestion and on the Structure of the Digestive Apparatus in the Myriapods of Belgium. Prof. Félix Plateau. (3 plates.)

BULLETIN DE LA SOCIÉTÉ BELGE DE MICROSCOPIE, Vol. V., No. 3:—

Proceedings of the Extraordinary General Meeting and of the Monthly Meeting of 26th December, 1878, containing:—

Report by M. Ledeganck on forty-eight mycological preparations presented by Dr. Zimmermann.

A word on the Gregarinæ, by M. Alex. Foettinger.

Notes of Micrography, by Dr. H. Van Heurck, No. III. The Camera Lucida of Dr. J. G. Hofmann. (4 woodcuts.)

Analytical and Critical Review of O. Nordstedt's 'De algis aquæ dulcis et de characis ex insulis Sandvicensibus a Sw. Berggren 1875 reportatis.'—'Cleve's Diatoms from the West Indian Archipelago.'—'Journal of the Royal Microscopical Society,' No. 6.—Dr. Hermann Fol's 'Commencement of Henogeny in various Animals.'

No. 4:—

Proceedings of the Extraordinary General Meeting of 23rd January, and of the Monthly Meeting of 30th January, 1879:—

The Terrestrial Diatomaceæ. Julien Deby.

The Rivet Microtome. M. Cornet.

Analytical and Critical Review of 'Revue des Sciences Naturelles de Montpellier' (and seven abstracts of recent scientific papers contained in it).—'Der Organismus der Infusionsthiere,' Part III., of Dr. F. Ritter von Stein.—'Diatoms,' Part III., edited by P. F. Cleve and J. D. Möller.—'Diatomacearum Species Typicæ,' Cent. IV., by H. L. Smith.—'Atlas der Diatomaceen,' by Ad. Smidt.—'Journal de Micrographie,' January, 1879.

Holland.

ARCHIVES NÉERLANDAISES DES SCIENCES EXACTES ET NATURELLES (published by the Dutch Society of Sciences at Haarlem), Vol. XIII., Parts 1-5:—

On the Determination of the Focal Distances of Lenses with short Foci. J. A. C. Oudemans. (5 figs. of a plate.)

On the Albumen of Serum and the Egg, and on its Combinations. A. Heynsius.

Comparative Studies on the Electric Action of the Muscles and the Nerves. Th. W. Engelmann.

On the Permeability of the precipitated Membranes. Hugo de Vries.

On the Influence of the Blood and Nerves on the Electro-motor Power of artificial transversal Sections of Muscles. By the same author.

New Researches on the Microscopic Phenomena of Muscular Contraction. By the same author. (1 plate.)

Germany.

ARCHIV FÜR NATURGESCHICHTE (Forty-fourth year), Vol. I., Part 1 :—

Development of some Venezuelan Butterflies after the Observations of Gollmer. Dr. H. Dewitz. (1 plate.)

Minor Fragments on the Comparative Anatomy of the Arthropoda. G. Haller. (1 plate.)

Contributions to the Natural History of the Invertebrate Animals of Kerguelensland. Prof. Th. Studer. (3 plates.)

Part 2 :—

New List of the Animals on which parasitic Insects live. Gurlt, with additions by Schilling.

Helminthological Contributions. Prof. Jos. Uliany. (1 plate.)

New Observations on Helminthia. Dr. v. Linstow. (3 plates.)

Short Notices on some new Crustacea, as well as new Localities of some already described. Prof. Dr. Robby Korsmann.

Part 3 :—

Attempt at a Natural Arrangement of the Spiders, with Remarks on individual Genera. Dr. Ph. Bertkan. (1 plate.)

Reflections on the Theory by which the Season-dimorphism in Butterflies is explained. Dr. P. Kramer.

Contributions to the Knowledge of the Hermaphroditism and the Spermatophores of Gasteropoda. Dr. George Pfeffer. (1 plate.)

Vol. II., Part 4 :—

Report on Researches on the Natural History of Mollusca during the year 1877. Troschel.

(Forty-fifth year), Vol. I., Part 1 :—

New Acarida. Dr. P. Kramer. (2 plates.)

Contributions to the Knowledge of the Lower Animals of Kerguelensland. Prof. Dr. Studer. (1 plate.)

On some Turbellaria of the White Sea. C. Mereschkowsky. (1 plate.)

The Fauna of Kerguelensland: List of the Species hitherto observed, with short notices on their appearance and their Zoo-geographical relations. Dr. Th. Studer.

BOTANISCHE ZEITUNG, Vol. XXXVII., Nos. 1-5 (January) :—

On Sprouting in the Leaves of Isoëtes. K. Goebel. (4 woodcuts.)

Observations on Entophytic and Entozootic Plant-parasites. P. F. Reinsch. (1 plate.)

On the Movements of Oscillatoricæ and Diatoms. Th. W. Engelmann.

Litteratur. — On *Discosporangium*, a new Genus of the Phæosporeæ. P. Falkenberg. (From 'Mittheilungen der Zoologischen Station zu Neapel,' Vol. I., Part 1.)

Phycological Studies: Analyses of Marine Algæ. Gustave Thuret.

Researches on the Protein-Crystalloids of Plants. A. F. W. Schimper.

Cryptogamic Flora of Silesia, Vol. II., Part 1, Algæ. O. Kirchner.

FLORA, N. S., Vol. XXXVII., No. 1 (January) :—

Contributions to the Knowledge of the Movements of growing Foliage and Flower Leaves. C. Kraus.

Reply by H. Banke to Dr. Prantl's Article on the Arrangement of the Cells in Flask-shaped Prothallia of Ferns.

HEDWIGIA, Vol. XVIII., No. 1 (January) :—

On a Natural System of Thallophytes. Dr. George Winter.

Ustilago Aschersoniana, F. de W., n. sp. A. Fischer v. Waldheim.

Repertorium.—Symbolæ ad Mycologiam Fennicam. IV. P. A. Karsten.

Literature and Collections.

LINNEA, N. S., Vol. XLII., Nos. 1-2 (1878). (Nil.)

MORPHOLOGISCHES JAHRBUCH, Vol. IV., Part 4 :—

Contributions to the Anatomy and Histology of the Sexual Organs of the Ossous Fishes. Dr. J. Brock. (2 plates.)

On the Female Sexual Apparatus of *Echinorhynchus Gigas*, Rud. Dr. Angelo Andres. (1 plate.)

Minor Communications.—On the Homology of the so-called Segmental Organs of the Annelida and Vertebrata. M. Fürbinger.

ZEITSCHRIFT FÜR MIKROSKOPIE, Vol. I., Parts 11–12 (December):—

On Micro-photographic Enlargement. Dr. S. Th. Stein. (1 woodcut.)

Reports on Nineteen Articles from various Serials, Books, &c.

Bibliography.

MONATSBERICHT — BERLIN ACADEMY, 1878 (September and October):—

Reply of Prof. Th. Schwann to the Congratulatory Address of the Academy on his Jubilee.

Summary of the *Anthozoa Aleyonaria* collected during the Voyage of the 'Gazelle' round the World. Prof. Dr. Th. Studer. (5 plates.)

November :—

The Crustacea collected by W. Peters in Mozambique. Dr. F. Hilgendorf. (4 plates.)

Austria.

ARBEITEN AUS DEM ZOOLOGISCHEM INSTITUTE DER UNIVERSITÄT WIEN UND DER ZOOLOGISCHEN STATION IN TRIEST, Vol. I., Parts 1–3:—

On *Halitemma Tergestinum*, n. sp., with Remarks on the finer Structure of the Physophoridae. Dr. C. Claus. (5 plates.)

Contributions to the Knowledge of the Male Sexual Organs of the Decapoda, with Comparative Remarks on those of the other Thoracostraca. Dr. C. Grobben. (6 plates.)

On the Origin of the Nervus vagus in Selachii, with regard to the Lobi electrici of the Torpedo. Josef Victor Rohon. (1 plate.)

Researches on the Structure of the Brain and the Retina of Arthropoda (and Supplement). Emil Berger. (5 plates.)

On *Charybdea marsupialis*. Dr. C. Claus. (5 plates.)

Studies on the Development History of the Annelida. Dr. Berthold Hatschek. (8 plates and 10 woodcuts.)

On the Organization of the Genera *Axine* and *Microcotyle*. Ludwig Lorenz. (3 plates.)

DENKSCHRIFTEN DER KAISERLICHEN AKADEMIE DER WISSENSCHAFTEN, Section I., Mathematics—Natural Science, Vol. XXXV.:—

The Crustacea, Pycnogonida, and Tunicata of the Austro-Hungarian North Polar Expedition. Prof. C. Heller. (5 plates.)

The Coelenterata, Echinodermata, and Vermes of the same Expedition. Dr. E. v. Marenzeller. (4 plates.)

(Vols. XXXVI. and XXXVII. were issued previous to 1st Jan., 1878.)

Vol. XXXVIII. :—

Studies on the Polypes and Medusæ of the Adriatic. I. *Acalephæ* (Discomedusæ). Prof. Dr. C. Claus. (11 plates.)

Contributions to the Investigation of the Phylogeny of Plants. Prof. Dr. C. v. Ettingshausen. (10 plates.)

Annual Period of the Insect Fauna of Austria-Hungary. III. Hymenoptera. K. Fritsch. (6 tables.)

The Fossil Miocene Bryozoa of Austria and Hungary. Part III. Dr. A. Manzoni. (18 plates.)

The Central Organ of the Nervous System of the Selachii. J. V. Rohon. (9 plates.)

On Refraction and Reflexion of Infinitely Thin Systems of Rays at Spherical Surfaces. L. Lippich. (1 plate.)

SITZUNGSBERICHTE—VIENNA ACADEMY, Vol. LXVII., Parts 1-5, Section III., Physiology, Anatomy, and Theoretical Medicine (January to May, 1878):—

On certain Sensations under the control of the Optic Nerves. By Ernst Brücke. (1 woodcut.)

On the Succession of Colours in Newton's Rings. By A. Rollett. (4 plates.)

Russia.

BULLETIN DE LA SOCIÉTÉ IMPÉRIALE DES NATURALISTES DE MOSCOU, Vol. LIII. (1878), No. 1:—

Attempt at a new Method to facilitate the Determination of the Species belonging to the Genus *Bombus* (continued). O. Radoskowski. (2 plates.)

Lichenes Finschiani. Müller Arg.

Lichenes Fischeriani. By the same author.

No. 2:—

Contributions to the Fungus Flora of Siberia. II. F. von Thümen.

List of the Beetles collected in the district of Kuldsha. E. Ballion.

MÉMOIRES DE L'ACADÉMIE IMPÉRIALE DES SCIENCES DE ST. PETERSBURG, Seventh Series, Vol. XXV.:—

On the Morphology of the Bacteria. Prof. L. Cienkowski. (2 plates.)

Annulata Semperiana. Contributions to the Knowledge of the Annelida Fauna of the Philippines in the Collections of Prof. Semper. Prof. Dr. Ed. Grube. (15 plates.)

Russian Spiral Foraminifera. Prof. Valerian v. Müller. (6 woodcuts and 15 plates.)

Vol. XXVI., No. 1:—

The Alga Flora of the White Sea and the adjacent parts of the Arctic Ocean. Christoph Gobi.

Italy.

MITTHEILUNGEN AUS DER ZOOLOGISCHEN STATION ZU NEAPEL, Vol. I., Parts 1-2:—

Observations on the Mode of Life of some Marine Animals in the Aquarium of the Zoological Station. R. Schmidtlein.

New Researches on Pycnogonidæ. Ant. Dohrn.

Carcinological Communications. Paul Mayer. (2 plates and 4 woodcuts.)

On *Discosporangium*, a new Genus of Phæosporeæ. P. Falkenberg. (1 plate.)

Halosphæra, a new Genus of Green Algae from the Mediterranean Sea. Dr. Fr. Schmitz. (1 plate.)

The Segmental Organs of the Capitellidæ. Dr. Hugo Eisig. (1 plate.)

Comparative Summary of the Appearance of the larger Pelagic Animals during the years 1875-1877. R. Schmidtlein.

Reports on the Zoological Station during the years 1876-1878. Anton Dohrn.

The Ctenophora appearing in the Gulf of Naples. Dr. Carl Chun. (1 plate.)

The Marine Algae of the Gulf of Naples. P. Falkenberg.

The Lateral and Crateriform Organs of the Capitellidæ. Dr. Hugo Eisig. (1 plate.)

NUOVO GIORNALE BOTANICO ITALIANO, Vol. XI. (1879), No. 1, January:—

Lichenes Insulæ Sardiniae. F. Bagliotto. (2 plates.)

Bibliography.—News.

BIBLIOGRAPHY

*Of Invertebrata, Cryptogamia, Embryology, Histology,
Microscopy, &c.*

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BROOME, C. E., F.L.S.—*See* Berkeley, Rev. M. J.

BRUNAUD, P.—The Common Names of the Fungi in the environs of Saintes (Charente-Inferieure).
Rev. Mycol., I., No. 1.

CASTILLON, Count de.—The Artificial Cultivation of Fungi in Japan.

Rev. Mycol., I., No. 1.

Cienkowski, Prof. L.—Bacteria as the cause of the Ropy Change of Beetroot Sugar. (*Abstr.* by Prof. Lankester.)
Quart. Journ. Mic. Sci., XIX., No. 73.

COMES, Dr. O.—Observations on some Species of Neapolitan Fungi.

Grevillea, VII., No. 43.

COOKE, M. C., and C. B. PLOWRIGHT.—British Sphæriacci.

Grevillea, VII., No. 43.

COOKE, M. C.—Californian Fungi.

" III., No. 43.

" " Mycographia seu Icones Fungorum: Figures of Fungi from all parts of the World. Vol. I., Discomycetes. Part 1. 113 plates. 8vo. London, 1879.

" " Some Exotic Fungi.

Grevillea, VII., No. 43.

CORNU, Dr. M.—Diseases of Plants caused by *Peronospora*, Mode of Treatment, &c. (*Transl.* from 'Comptes Rendus.')

Grevillea, VII., No. 43.

" " The Maple Disease (*Rhytisma accrinum*). (*Transl.* from 'Comptes Rendus.')

Grevillea, III., No. 43.

CRÉÉ, L.—Researches on the *Depazeæ*. 8 plates.

Ann. Sci. Nat. (Bot.), VII., Nos. (1 & 2).

CUNNINGHAM, D. D., M.B., F.L.S.—On the occurrence of Conidial Fructification in the *Mucorini*, illustrated by *Choanephora*. 1 plate.

Trans. Linn. Soc. (Bot.), I., Part 6.

DESTREM, A.—*See* Schützenberger, P.

FISCHER DE WALDHEIM, A.—*Ustilago Aschersoniana* F. de W., n. sp.

Hedwigia, XVIII., No. 1.

HINE, F. B., B.S.—Observations on several Forms of *Saprolegniæ* (concluded).

Am. Quart. Mic. Journ., No. 2.

HOOKE, Sir J.—*See* Botany A.

LANKESTER, Prof. E. R.—*See* Cienkowski, Prof. L.

MOREAU, H.—*See* Bergeret.

PASSERINI, Prof.—Two Species of *Peronospora*.

Grevillea, VII., No. 43.

PASTEUR, M.—Observations on the Communication of M. Trécul. [On Alcoholic Fermentation.]—Reply to the Notes of M. Trécul of the 30th December and 13th January.—Observations on his Reply.—Verbal Observations on his last Reply and Further Reply.
Comptes Rendus, LXXXVIII., Nos. 2, 3 & 6.

" " Second, Third, and Fourth Replies to M. Berthelot.

Comptes Rendus, LXXXVIII., Nos. 2, 4, & 6.

- PLANCHON, J. E.—The Polymorphism of *Agaricus melleus* Vahl.
Comptes Rendus, LXXXVIII., No. 2.
- FLOWRIGHT, C. B.—See Cooke, J. C.
- QUÉLET, Dr. L.—The Myxogastres. *Rev. Mycol.*, I., No. 1.
- REINSCH, P. F.—See Algae.
- ROUMEGUÈRE, C.—Extraordinary Case of Development of *Bovista gigantea* Nees, in the environs of Toulouse. *Rev. Mycol.*, I., No. 1.
- „ „ Origin of the Genus *Microsphaeria* Leveillé. *Rev. Mycol.*, I., No. 1.
- „ „ On *Telephora palmata* Fries. *Forma paradoxa* Nob. *Rev. Mycol.*, I., No. 1.
- „ „ The Preservation of Fungi from a Scientific point of view. *Rev. Mycol.*, I., No. 1.
- „ „ See Microscopy.
- SCHÜTZENBERGER, P., and A. DESTREM.—Researches on Beer Yeast. *Comptes Rendus*, LXXXVIII., No. 6.
- „ „ On the Composition of Beer Yeast. *Comptes Rendus*, LXXXVIII., No. 8.
- SEYNES, J. DE.—On the Disease of the Chestnut-trees. *Comptes Rendus*, LXXXVIII., No. 1.
- THÜMEN, F. DE.—Fungi Pomicoli—Monograph of the Fungi occurring on the Fruits of Temperate Climates. 3 plates. Svo. Vienna, 1879.
- „ „ Fungorum Novorum Exoticorum Decas. *Rev. Mycol.*, I., No. 1.
- TIEGHEM, P. VAN.—On the Fermentation of Cellulose. *Comptes Rendus*, LXXXVIII., No. 5.
- TRÉCUL, A.—Reply to M. Van Tieghem as to the Origin of Amylobacter. *Comptes Rendus*, LXXXVIII., No. 9.
- „ „ Do there exist among the lower organisms species exclusively aërobian and others anaërobian? &c. *Comptes Rendus*, LXXXVIII., No. 2.
- „ „ Reply, last Reply, and [further] Reply to M. Pasteur. *Comptes Rendus*, LXXXVIII., Nos. 3 & 6.
- WILLIAMS, C. F. W. T.—See Microscopy.

Muscineæ.

- BESCHERELLE, EM.—Note on three New Species of Mosses of New Caledonia, belonging to the Genus *Pterobryella* C. Müll. *Bull. Soc. Bot. France*, XXV., Part 1.

Vascular Cryptogams.

- BAUKE, H.—Reply to Dr. Prantl's Article on the Arrangement of the Cells in Flask-shaped Prothallia of Ferns. *Flora*, XXXVII., No. 1.
- GOEBEL, K.—On Sprouting in the Leaves of Isoëtes. 4 figs. *Bot. Zeit.*, XXXVII., No. 1.

MICROSCOPY, &c.

- ADAN, H. P.—The Invisible World Revealed. Parts 1 to 8. 16 plates. Svo. Brussels and Paris, 1879.
- American Quarterly Microscopical Journal. *Am. Nat.*, XIII., No. 3.
- BEDWELL, F. A.—The Oil-Immersion $\frac{1}{8}$ inch. *Midl. Nat.*, II., No. 13.
- BLACKHAM, Dr. G. E.—Angular Aperture of Microscope Objectives (*contd.*). 2 plates. *Journ. de Micr.*, III., Nos. 1 & 2.
- BREWSTER, W.—On Mounting and Preserving the Larvæ of Butterflies and Moths. *Sci.-Gossip*, No. 171.
- BROWNING's Compound Achromatic Microscope. 1 fig. *M. Journ. Sci.*, I., No. 62.
- CERTES, A.—On a Method of Preserving Infusoria. *Comptes Rendus*, LXXXVIII., No. 9.
- CHESTER, H.—Artificial Crystals of Gold and Silver. 5 figs. *Am. Journ. Micr.*, IV., No. 1.
- CLARK, F. C.—Removal of Air from Microscopic Specimens. *Am. Nat.*, XIII., No. 1.

- CLINCH, G.—A new Lamp for Microscopic Mounting. *Sci.-Gossip*, No. 169.
 COLE & SON, Cabinet of Microscopy of. *Journ. de Micr.*, III., No. 2.
 COLLINS, C., Histological Microscope of, 1 fig. " " " " " " No. 1.
 CORNET, M.—The Rivet Microtome. *Bull. Soc. Belg. Micr.*, V., No. 4.
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 DUVAL, M.—On the Employment of Wet Collodion for Microscopic Sections. *Journ. Anat. et Phys. (Robin)*, XV., No. 2.
 FELL, G. E.—Microscopic Soirées — An Improved Method of Exhibiting Objects. *Am. Journ. Micr.*, IV., No. 1.
 [FORREST, H. E.]—Apparatus for Drawing Objects under the Microscope. *Midl. Nat.*, II., No. 13.
 HAGER, Dr. H.—The Microscope and its Employment. 6th Ed. 231 figs. 8vo. Berlin, 1879.
 HENNEGUY, F.—Method of Investigating the Embryos of Fishes. (*Transl.* from 'Bull. Soc. Philom. Paris.'). *Ann. & Mag. Nat. Hist.*, III., No. 15.
 HINCKS, S. C.—How to remove Canada Balsam from Slides. *Sci.-Gossip*, No. 171.
 HYDE, H. C.—The Microscope in Medical Jurisprudence. *Am. Journ. Micr.*, IV., No. 1.
 I., T. R.—Hints for the Young Microscopist. 2 figs. *Sci.-Gossip*, No. 170.
 KITTON, F.—New Forms of Camera Lucida. 1 fig. [Hofmann's.] *Sci.-Gossip*, No. 171.
 LANKESTER, Prof. E. R.—[Microscopical] Research under Difficulties. *Nature*, XIX., No. 485.
 Microscopical Library, Sale of a. *Am. Nat.*, XIII., No. 3.
 MORLEY, E. W., M.D., Ph.D.—On the Probable Error of Micrometric Measurements. *Am. Quar. Micr. Journ.*, I., No. 2.
 MOJSISOVICS, Dr. A.—Practical Guide for Students in making Zoological-Zootomical Preparations. 110 figs. 8vo. Leipzig, 1879.
 New [American] Microscopical Societies. *Am. Nat.*, XIII., No. 3.
 PLESSIS, G. du.—Note on Preparing and Preserving Delicate Organisms. (*Transl.*) *Sci.-Gossip*, No. 171.
 ROGERS, Prof. W. A.—Limits of Accuracy in Measurements with the Microscope. *Am. Nat.*, XIII., No. 1.
 " " Standard Measures of Length. *Am. Quar. Micr. Journ.*, I., No. 2.
 ROUMÈGUÈRE, C.—The Microscopical Study and Preparation of Fungi. *Rev. Mycol.*, I., No. 1.
 " " Microscopical Slides of Fungi of the Rev. J. E. Vize. *Rev. Mycol.*, I., No. 1.
 SEILER, CARL, M.D.—Practical Hints in Preparing and Mounting Animal Tissues. 2 figs. (*In part.*) *Am. Quar. Micr. Journ.*, I., No. 2.
 SMITH, A.—A Live Box. 2 figs. *Sci.-Gossip*, No. 170.
 " " A Novel Air-pump for removing Air-bubbles in Slides. 1 fig. *Sci.-Gossip*, No. 171.
 " " New Form of Collecting-cane. 1 fig. *Am. Journ. Micr.*, VI., No. 1.
 SMITH, J. EDWARDS, M.D.—[Beek's Vertical Illuminator.] *Am. Nat.*, XIII., No. 2.
 Society Screw. " " No. 1.
 Spring Clips (Hawley's). " " No. 3.
 THIN, G.—See Zoology A.
 TOLLES' $\frac{7}{8}$ Objective. *Am. Journ. Micr.*, IV., No. 1.
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 WILKINS, T. S.—Microscopic Pond Life. (Paper read before the "North Staffordshire Naturalists' Field Club.") *Am. Journ. Micr.*, IV., No. 1.
 WILLIAMS, C. F. W. T.—On Mounting Micro-Fungi. 1 fig. *Sci.-Gossip*, No. 169.
 Williams, W. M.—Spider's Web for Micrometers. (From 'Journ. Soc. Arts.'). *M. Journ. Sci.*, I., No. 62.
 ZENTMAYER'S Reversible Diatom Stage. " "

PROCEEDINGS OF THE SOCIETY.

ANNUAL MEETING OF 12TH FEBRUARY, 1879, AT KING'S COLLEGE,
STRAND, W.C.

H. J. Slack, Esq., President, in the Chair.

The Minutes of the meeting of 8th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Brewer, J. A.—Flora of Surrey. 1863	<i>Mr. Crisp.</i>
Chester Society of Natural Science—Proceedings. No. 2. 1878	<i>Mr. Thos. Shephard.</i>
Drysdale, J., M.D.—The Germ Theories of Infectious Diseases. 1878	<i>The Author.</i>
Hoggan, G. and F. E.—Étude sur les Lymphatiques de la Peau. (Extracted from the 'Journal de l'Anatomie and de la Physiologie')	<i>The Authors.</i>
Koerber, Dr. G. W.—Systema Lichenum Germaniæ. 1855	<i>Mr. Crisp.</i>

The President read his Address (see p. 113).

Dr. Matthews said that the President, at the commencement of his address, had stated that he could hardly hope to rival that delivered at their previous anniversary by Mr. Sorby, but he was sure that all present would agree that they could not have had laid before them more interesting and important matters than those which had been dealt with that evening, and he had great pleasure in moving that the cordial thanks of the meeting be given to the President for his address, and that it be printed and circulated in the usual way.

Dr. W. J. Gray having seconded the motion,

Dr. Matthews put it to the meeting, and declared it to be carried unanimously.

The President then read a copy of a letter which he had addressed to the Council as to his reasons for not offering himself for re-election for another year, which was followed by remarks from Mr. Crisp and from Dr. Matthews on behalf of the Council.

Mr. C. Brooke, F.R.S., then took the chair.

The Report of the Council was read by the Junior Secretary, Mr. Crisp (see p. 216), various passages being received with demonstrations of approval from the meeting.

Mr. Glaisher, F.R.S., said he rose with a great deal of pleasure to

move the adoption of the report. Having long been connected with the Society, and having always taken a lively interest in its welfare, it was indeed a source of pleasure to him to find that it now had a larger annual income than at any previous time, which, coupled with the fact that it had upwards of 2100*l.* to the credit of capital, was of itself full evidence that the Society was prospering and flourishing.

With regard to the Journal, it was impossible for him to look back upon the past without recalling how the late Rev. J. B. Reade, Dr. Bowerbank, and himself had always worked together to secure to the Society an independent Journal, not connected in any way with the interests of trade. They had that now, and he had seen the recent numbers with the greatest satisfaction, and could read them again and again.

When he had the honour some years ago of filling the Presidential chair, he had suggested that they should take means for bringing kindred societies into closer connection with themselves. His idea then was that the Societies should pay 10*s.* a year, or some such arrangement. The fact that a proposition was to be brought forward now to connect these kindred societies was particularly pleasing to him. Their own object was to diffuse and encourage microscopical study and inquiry, and there were many excellent workers amongst the provincial societies in this country, whom it would be honourable to the Society to recognize. It was therefore with very much more than usual pleasure that he moved "That the Report be received and adopted, and that it be printed and circulated in the usual way."

Mr. T. Charters White had much pleasure in seconding the resolution which had been so warmly spoken to by Mr. Glaisher, and he cordially approved of the proposal in regard to other societies.

The Chairman having put the motion, declared it carried unanimously.

Mr. Crisp then moved the following amendment to the Bye-laws:—

"I. The 1st Bye-law shall read as follows:—

1. The Society shall consist of Fellows, and Ex-officio, Honorary, and Corresponding Fellows and Associates.

II. The following Bye-law shall be inserted after No. 15 *a*, to be numbered No. 15 *b*:—

15 *b*. The Ex-officio Fellows shall consist of the Presidents for the time being of such Societies at home or abroad as the Council may from time to time recommend and an ordinary or annual meeting may approve. During their term of office they shall be entitled to receive the publications of the Society and to exercise all other privileges of Fellows except that of voting, but shall not be required as Ex-officio Fellows to pay any entrance fee or annual subscription."

He said that after having laid his proposition as to Ex-officio Fellows before the members of the Council and obtained their approval of it, he had canvassed the matter amongst such of the Fellows generally as he had been able to meet with during the past

two months, and the only difficulty that he had experienced was that it was too uniformly approved. He spoke of that as a "difficulty" because it was always desirable when what might be termed radical changes were mooted, that both sides of the question should be placed before the meeting, which was thereby enabled to come to a sounder decision. At the eleventh hour, however, he had been able to meet with a Fellow who entertained some objections.

Mr. J. W. Stephenson having seconded the motion,

Mr. Curties said that his objection to Mr. Crisp's proposal might be stated in a word. He thought, as Mr. Glaisher had put it, that the societies should pay a small subscription, as it was intended that they should receive the Journal free of charge. It seemed to him that if they were to be giving their valuable Journal in perpetuity in this way, they might some day have cause to be sorry for it. Whether this liberality was justified by their present prosperity he would not venture to say, but it should be remembered that at the present time their Honorary Fellows did not receive the Journal.

A further discussion ensued, in which Mr. T. C. White, Mr. James Smith, Dr. Braithwaite, and others took part, after which the Chairman put the motion to the meeting and declared it to be carried unanimously.

Mr. Stephenson, the Treasurer, presented his accounts for the year 1878 (see p. 218).

Dr. Braithwaite moved that the accounts be received and adopted, and printed and circulated as usual, which was seconded by Mr. Glaisher, and carried unanimously.

The List of Nominations for the Council was then read, and the Chairman nominated Mr. A. D. Michael and Mr. T. C. White Scrutineers.

The Scrutineers having handed in their report of the result of the ballot,

The Chairman announced that the following Fellows (being those whose names appeared in the list of nominations) were duly elected:—

President—* Lionel S. Beale, Esq., M.B., F.R.S.

Vice-Presidents—* Robert Braithwaite, Esq., M.D.; Charles T. Hudson, Esq., M.A., LL.D.; * Henry J. Slack, Esq., F.G.S.; and Henry C. Sorby, Esq., F.R.S., Pres. G.S.

Treasurer—John Ware Stephenson, Esq., F.R.A.S.

Secretaries—Charles Stewart, Esq., M.R.C.S.; Frank Crisp, Esq., LL.B., B.A.

Twelve other Members of Council—John Badcock, Esq.; William A. Bevington, Esq.; Charles James Fox, Esq.; * James Glaisher, Esq., F.R.S., F.R.A.S.; * A. de Souza Guimaraens, Esq.; William J. Gray, Esq., M.D.; * John E. Ingpen, Esq.; Emanuel W. Jones, Esq., F.R.A.S.; * William T. Loy, Esq.; John Matthews, Esq., M.D.; John Millar, Esq., L.R.C.P.E.; and Thomas Palmer, Esq., B.Sc.

* Have not held during the preceding year the office for which they were nominated.

Dr. Lionel S. Beale, M.B., F.R.S., was then called upon by Mr. Brooke to take the chair as President of the Society, and in doing so was received with loud and long-continued cheering. He said that he felt deeply indebted to the Society for the honour which they had done him in electing him their President, and for the warmth with which he had been received. It would be his duty as well as his pleasure to come amongst them as often as possible, and as he had for some years paid comparatively little attention to the Microscope, he expected to learn a great deal by attending the meetings.

Mr. Stephenson said he had received from Professor Abbe some photographs of *Amphipectura pellucida* and *Pleurosigma angulatum*, which had been sent to him by Dr. Woodward, together with a letter containing Dr. Woodward's opinion of the oil-immersion objectives (part of the letter was read, see p. 140, and the photographs were handed round).

A Letter was read from Mr. Badcock, in which he pointed out that in the report of the meeting of 11th December last, he was made to say, in reference to *Æcistes umbella*, "at which time he showed it to Mr. Oxley." What he said was that he had had a sketch made of it at the time, which he had recently shown to Mr. Oxley.

Mr. Crisp said that a grave charge had been made against him, which really belonged to the Society, and he would therefore take this opportunity of transferring it to the right shoulders. It was said that when a large and complicated form of Microscope was made, it was invariably brought to the Society and exhibited, but that they never exhibited any of the smaller and cheaper forms from time to time produced—that out of 1000 microscopists, however, 999 used the latter instruments, and only the one man in the 1000 the former, so that they failed somewhat in their duty in not giving at least equal encouragement to what it was contended was the more useful instrument in the strict sense of the term. He must say (speaking entirely for himself) that he thought this suggestion was not without force, and by way of doing penance for his own shortcomings he had brought, and begged to present to the Society, three of the recent smaller instruments—the "Model" of Messrs. Baker, the "Binocular Economic" of Messrs. Beck, and the "Alpha" School Microscope of Mr. Crouch.

Mr. Stephenson said that if Mr. Crisp was not tired of receiving the thanks of the Society he should like to move a vote of thanks to him for his valuable presents.

Dr. Braithwaite having seconded the motion, it was put to the meeting and carried unanimously.

The following were exhibited:—

Mr. Badcock:—Three lithographs of Infusoria on a black ground, illustrating a new method.

Mr. T. J. Parker:—Slides of Copepoda, prepared with osmic acid.

Mr. Stephenson:—(1) Five forms of his catoptric immersion illuminator, viz.:—

Three of 1-inch, $\frac{1}{2}$ -inch, and $\frac{1}{4}$ -inch radius, as described in this Journal, vol. ii. p. 36.

A cylindrical illuminator of 1-inch radius on the same principle.

A fifth consisting of two lenses, a meniscus and plano-convex, the curvature of the latter coinciding with the curved surface of the former, so that the achromatism is preserved whilst there is no interference with the power of total reflection at the surface where the film of air between the lenses intervened.

(2) The following photographs taken by Dr. Woodward (lent by Professor Abbe):—

Amphipleura pellucida, in balsam. Zeiss' $\frac{1}{12}$ oil immersion (2630 diameters).

Same valve. Zeiss' $\frac{1}{8}$ oil immersion, with Tolles's amplifier (2500 diameters).

Same valve. Powell and Lealand's $\frac{1}{25}$ water immersion (2780 diameters).

Same valve. Powell and Lealand's new $\frac{1}{6}$ water immersion (2565 diameters).

Same valve. Spencer's $\frac{1}{10}$ glycerine immersion, with Tolles's amplifier (2440 diameters).

Pleurosigma angulatum (hexagons). Zeiss' $\frac{1}{12}$ oil immersion (2400 diameters).

Same (diffraction lines—Abbe's experiment). Zeiss' $\frac{1}{8}$ oil immersion (1700 diameters).

Mr. Ward:—(1) Sections (double stained) of stem of *Gulancha* (*Tinospora cordifolia*). (2) Sections (double stained) of stem of *Rhipsalis Cassytha* (Cactaceæ).

Mr. Crisp:—(1) Baker's "Model" histological Microscope. (2) Beck's small binocular Microscope on the "Economic" principle, with American glass stage. (3) Crouch's "Alpha" school Microscope, with dividing object-glass. (4) Professor Möbius's elaborate treatise on "The Structure of Eozoon Canadense." (5) The preparations of whole insects of Herr Petzold, of Vienna, described in 'Nature,' vol. xix. (1879) p. 301, and lent by the editor.

New Fellows.—The following were elected Fellows of the Society, viz.:—Messrs. T. Brown; L. Dreyfus; C. A. Lucas; W. M. Marshall J.P.; and T. J. Parker, Assoc. R.S.M.

REPORT OF THE COUNCIL

PRESENTED TO

THE ANNUAL MEETING.

General Position of the Society.

IN presenting their Report at the close of the 40th year of the Society's existence the Council have much pleasure in congratulating the Fellows upon its continued and increasing prosperity and vitality.

The number of Fellows is now 437. Eleven were elected during the past year in excess of the number elected in 1877, and twelve nominations for Fellowship have been received since the beginning of this year.

Finances.

The Finances of the Society are in a very satisfactory condition. The Annual Income is now larger than at any previous time; whilst as regards Capital, the funds invested in Consols and India Stock, together with the Cash in hand, amount to upwards of 2100*l.*, as will be seen from the Treasurer's Accounts presented with this Report.

New Rooms.

The Council are glad to be able to announce that negotiations are pending with the authorities of King's College, by which it is anticipated that the Society will have the use of more commodious and convenient rooms.

Library, Instruments, &c.

The Council thought it prudent to limit the expenditure during the past year on the Library, Instruments, and Apparatus, on account of the difficulty that existed in forming any reliable estimate of the probable cost of the Journal, but now that that expenditure has been ascertained, and having regard to the amount of the Society's Capital, they see no reason why the full surplus of Income should not be annually expended in additions to the Library and Apparatus, leaving only the composition fees to accumulate in future for the benefit of the Capital Account.

Several valuable additions have, however, been made to the Library during the past year, including (from Mr. Crisp) 27 volumes of the 'Annales des Sciences Naturelles,' 10 volumes of the 'Zeitschrift für wissenschaftliche Zoologie,' and 6 volumes of 'Grevillea,' together with other works. The Council have also accepted from the same Fellow a Cabinet for the Instruments, &c., and additions have been made to the Apparatus and Objects.

A detailed and very complete Catalogue of the Instruments and Apparatus has been made by Mr. Fox. The revision of the Library Catalogue, and the re-arrangement of the Books according to subjects was also determined upon, but these matters have necessarily been postponed in consequence of the contemplated change of rooms.

Journal.

The Council have been gratified to learn that the new series of the Journal has met with general approval. A leading feature of the Journal (apart from the Transactions and Proceedings of the Society) consists of Notes of the observations and investigations of interest in Biology which are recorded in the Publications of the principal Academies and Learned Societies throughout the world, or in the other serial publications of this and other countries.

The Council find that this plan is looked upon with satisfaction, not only by those Fellows who, from being resident in the provinces, are unable

to obtain access to many of the works through which such observations are scattered, but also to the Fellows and Biologists generally in London, who, apart from the fact of the original communications being in most cases in a foreign language, are assisted in their researches by having the salient points of recent investigations collected together in a condensed form.

One of the Secretaries has kindly undertaken (as an honorary office) the Editorship of the Journal.

Business at the Meetings.

The Council are of opinion that it would be useful, in the best sense of the term, that any important observations in Biology made by Foreign Observers should be noticed at the Meetings, and with this view they have requested the Secretaries to bring to the notice of the Meetings any such observations, illustrated by drawings where possible. The Council will be glad to receive the co-operation of other Fellows in carrying out this object.

The Council have taken into consideration the necessity of making some alteration in the proceedings at the Meetings, so as to avoid their being protracted to the late hour that has lately been rendered necessary by the pressure of business to be disposed of, and they think that a sufficient remedy will be found in providing that Papers shall not be read *in extenso*, except in special cases. They hope that by this means it may be found possible to conclude the business by half-past nine, leaving a longer period for tea and coffee, conversation and the examination of the objects exhibited.

Association of kindred Societies.

A suggestion has been made to the Council that some plan should be devised by which other Societies founded for kindred objects should be brought into association with this Society. It would not of course be possible to provide that the Members of other Societies should *ipso facto* be entitled to the privileges of Fellows, but the Council propose that the Presidents for the time being of such kindred Societies at home or abroad as the Council may from time to time recommend, and the Fellows at an Ordinary or Annual Meeting approve, shall be *ex-officio* Fellows, being entitled to receive the 'Journal' on behalf of their Societies, and to exercise all other privileges of Fellows except voting. The Council do not propose that this should be limited to those bodies which include in their title the term "Microscopical" (a term which, as applied to Societies mainly devoted to Biological and Histological investigations, has now lost most of its original import), but should include all whose principal object is Biological Research in any of its branches.

An amendment of the Bye-laws will be proposed at the Meeting to enable this to be carried into effect.

Quekett Fund.

The Council have turned their attention to the disposal of the Quekett Fund, which has now accumulated at interest for some years until it amounts (taking the cash value) to upwards of 180*l*.

The Council have determined to recommend to the Annual Meeting that a sum shall be applied in the purchase of books (not reducing the fund below 100*l*.), the balance being invested, and the income of the investments expended annually for a similar purpose, the books to bear an inscription indicating the source from which they were purchased. The Council consider that in this way the Fund will be applied in the most suitable manner, as regards utility to the Fellows and the perpetuation of the memory of the President, in whose honour it was formed.

MEETING OF 12TH MARCH, 1879, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT, DR. BEALE, F.R.S., IN THE CHAIR.

The Minutes of the meeting of 12th February were read and confirmed, and were signed by the President.

The President said that the amount of business on the agenda that evening was so great that it would be necessary to compress the different matters as much as possible, or they would not be able to include them all.

The following Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors:—

	From
Corden, G.—The Meteorology of Croydon. 1878. <i>The Croydon Mic. and Nat. Hist. Club.</i>	
Harting, P.—Recherches de Morphologie synthétique sur la production artificielle de quelques Formations Calcaires Organiques. 1872	<i>The Author.</i>
Rabenhorst, Dr. L.—Deutschland's Kryptogamen-Flora. 1844-5	<i>Mr. Crisp.</i>
Siddall, J. D., and H. B. Brady.—Catalogue of British Recent Foraminifera, for the use of Collectors. 1878	<i>The Authors.</i>

Four slides of "Fossil Diatoms" from Richmond, Va., Petersburg, Va., and Nottingham, M.D. (U.S.), were presented by Mr. C. L. Peticolas, through Mr. A. Allen, the Secretary of the Postal Microscopical Society.

Mr. Crisp mentioned that he had arranged with Mr. Bolton to send him a supply of living specimens, which he would bring to the Wednesday evening meetings, and would be glad to continue the arrangement if it were found that the Fellows made use of it.

Lists of Nominations under the new Bye-law relating to Ex-officio Fellows and of Honorary Fellows were read by the President.

The President announced the completion of arrangements with the authorities of King's College for the occupation by the Society of the room in the south corridor.

Mr. A. D. Michael gave an abstract of his paper, "A Contribution to the Knowledge of British Oribatidæ," accompanied by two large coloured drawings and four slides.

The President invited observations upon Mr. Michael's paper, and remarked that there was a great deal of interest connected with the circumstance he mentioned as to the apparent ability of these creatures to perceive light without being possessed of eyes. There were evidences to be found amongst the higher animals of a power of receiving impressions of light without the aid of an ophthalmic organ.

Mr. T. J. Parker inquired if Mr. Michael had found out anything

as to the nature of the white powder mentioned as being found upon one species of the mites?

Mr. Michael said that he had little doubt as to the use of this powder, which seemed clearly to be of a protective character. Many other species not provided with powder, made a similar protection for themselves by rolling in the mud. As to its origin, he was unable to say anything with certainty, but thought that the cast skins had something to do with it.

The thanks of the meeting were given to Mr. Michael for his paper.

Dr. George Hoggan read parts of a paper "On the Development and Retrogression of Fat-Cells," in which the results of a series of observations and experiments carried out by himself and Mrs. Hoggan were minutely detailed. The subject was well illustrated by preparations exhibited under twelve Microscopes in the room.

The President, in proposing a vote of thanks (which was carried unanimously) for Dr. Hoggan's very interesting communication, said that so many points of interest had been referred to that a great deal of time would be needed to discuss it thoroughly.

Mr. Beck placed upon the table and described in detail a new large binocular Microscope which he had devised with swinging bar for condenser, mirror, and lamp, and with improved movements, and invited the Fellows to criticise it freely at the close of the meeting, with a view to its possible further improvement.

Mr. Crisp, in calling attention to the new $\frac{1}{8}$ oil-immersion objective of 1.26 numerical aperture (or the large balsam angle of $114^{\circ} 18'$), said that they had a very interesting communication from Professor Abbe on oil-immersion objectives in general, which there was unfortunately no time to read, but of which he would briefly mention the chief points.

In the first place, the Society would be pleased to find that Professor Abbe had given full credit to England, and to this Society in particular, in regard to the origination of these objectives, his paper read before the Jena Society being entitled "On Stephenson's System of Homogeneous Immersion for Microscope Objectives."

Professor Abbe had also turned his attention to finding *aqueous* fluids fit for homogeneous immersion, and believed that "*distilled* chloride of zinc dissolved in water will prove to be an excellent substitute for the oil of cedar wood. It does not dissolve balsam, and can be cleared off by water, and does not flow like the cedar-oil; its consistence is like thick olive oil." Professor Abbe added that he is making experiments with other preparations, from which he expects good results.

A third point related to a suggestion recently made by Mr. Stephenson that, looking to the large working distance of the oil-immersion system and the optical homogeneity of crown glass and the immersion fluid, the front lens of the objectives, instead of being held

in place by the brass setting (whereby necessarily a greater or less part of the periphery of the lens was rendered ineffective), should be fixed by balsam to a thin plate of parallel glass rather larger than the lens, the plate itself being attached by its periphery to the brass mounting. Professor Abbe, in reply, said that he had last summer tried the plan with perfect success in some experiments made to test its efficiency, and that several $\frac{1}{8}$ ths had been so constructed. The device necessarily introduced a very delicate additional point into the optical system (the balsam film), and it would not be prudent to apply it where it is not absolutely necessary, but it was the only way, in his opinion, by which an objective of 1.35 numerical aperture ($= 128\frac{1}{3}^\circ$ balsam angle) could be made, and he hoped before long to accomplish this.

Mr. Wenham said he should like to observe, with reference to the proposed method of fixing the front lens, that Mr. Tolles about eight years ago constructed an objective in which the front was fixed in a similar way.

Mr. J. Mayall, jun., said that he had examined the new $\frac{1}{18}$ oil-immersion belonging to Mr. Crisp, and had measured the aperture with the Abbe apertometer. He found it slightly less than the figure which had been mentioned. As to flatness of field, it did not show that as he should have expected to see it in similar powers by Powell and Lealand or by Tolles. Whether flatness of field was a desirable quality or not, he would not engage to decide; it was, at any rate, a quality much sought for by certain opticians. The lens was specially designed for immersed objects or for objects in close contact with the cover-glass, and when used on such objects gave fine definition. With an immersion illuminator he had seen the striæ of *Amphipleura pellucida* in balsam by lamplight with this lens more easily than with any other he had examined.

Mr. T. J. Parker read a paper by himself, "On some Applications of Osmic Acid to Microscopical Purposes," illustrated by four slides.

The President said that the Society was much obliged to Mr. Parker for bringing the method described before them, as it appeared from the specimens exhibited to be a very excellent one.

Mr. Crisp said that some little misconception seemed to exist in America as to the discussion at the October meeting on a unit of micrometry. At the end of that discussion Dr. Edmunds made some remarks on the Society's standard screw *for objectives*. This had apparently been supposed to refer to a "Whitworth screw carefully kept in the custody of the Society" as a standard *for micrometric measurements*, and was so referred to in an article by Professor Rogers in the January number of the 'American Quarterly Microscopical Journal.' As Professor Rogers, acting on this assumption, proceeds to explain that "an absolutely perfect screw cannot be taken as a standard, and hence this proposition of our friends abroad is hardly feasible" (for reasons which we must all readily recognize), it seemed desirable to make this correction.

It was also stated by Professor Rogers that he had a large collection of micrometers by different makers at home and abroad, including transfers from every well-known precision-screw in the United States; and although his investigations were not yet quite completed, he felt safe in saying that no two of them agree at a given temperature, the errors of subdivision being in many cases very large, and in all cases easily measurable.

Mr. Crisp further said that it was now four months since he brought before the Society the resolutions passed at the Indianapolis Congress of American Microscopists in August last, recommending the universal adoption of the $\frac{1}{1000}$ of a millimetre as the unit of micrometry. As apart from the discussion that took place at the October and December meetings,* the subject had been thoroughly ventilated in the interim, there seemed no reason for postponing the subject further, and therefore with the view of bringing the matter to an issue one way or the other, he would give notice of moving the following resolution at the April meeting:—

“That in the opinion of this Society the most convenient unit for micrometric measurements would be the $\frac{1}{1000}$ of a millimetre.”

He had purposely abstained from framing the resolution as in any way a recommendation which it might be considered they had no right to make, leaving it to express simply the opinion of the Society as to the most convenient unit.

In support of the first point embraced by the resolution, viz. the selection of a subdivision of the metre and not of the inch, it was hardly necessary to remind the meeting of the extent to which the millimetre was used at the present time in the scientific world; whilst as to the second point, the adoption of the $\frac{1}{1000}$ of a millimetre instead of the $\frac{1}{100}$, it would be borne in mind that the former, which was first suggested in Holland, was now the accepted Continental standard (under the name of micro-millimetre), with the special symbol μ (or sometimes Mik.), and was to be found in the works of both French and German writers (particularly diatomists), and in the Proceedings of the principal Continental learned Societies. Even without this to recommend it, he thought there could be little or no difference of opinion that $\frac{1}{100}$ of a millimetre was far too large a standard.

If it was considered desirable for any purpose not to lose sight of the inch altogether, the plan suggested by Mr. Beck of showing, on one micrometer, subdivisions both of an inch and of a millimetre, was a very convenient one.

Professor Keith's paper, “Note on Mr. Wenham's paper ‘On the Measurement of the Angle of Aperture of Objectives,’” was taken as read in consequence of the lateness of the hour.

Mr. Tolles' paper on “An Illuminating Traverse Lens” was postponed until the next meeting.

* See this Journal, vol. i. p. 310, and vol. ii. p. 103.

A Note by Mr. Crisp "On the Poison Apparatus and Anal Glands of Ants" (illustrated by two drawings) was taken as read for the same reason.

The President announced that after the conclusion of the ordinary meeting in April a special general meeting would be held to make two alterations in the Bye-laws. First, to provide that the composition fee payable by all Fellows hereafter elected should be 31l. 10s. instead of 21l.; and secondly, that the Presidents or Chairmen of the Biological or Microscopical sections of Societies coming under Bye-law 15 *b* might be elected Ex-officio Fellows in lieu of the Presidents of the Societies.

The following objects, &c., were exhibited:—

Mr. A. D. Michael:—Four slides illustrating his paper, viz.: (1) *Tegeocranus latus*, nymph (newly traced). (2) *Tegeocranus latus*, perfect creature. (3) *Tegeocranus labyrinthicus*, nov. sp. (4) *Scutovertex sculptus*, nov. sp.

Dr. and Mrs. Hoggan:—Twelve slides illustrating their paper, consisting of preparations from (1 & 2) the broad ligament of the uterus in a pregnant mouse; (3 & 4) from the mesentery of a rat; (5 & 6) from the mesentery of a guinea-pig; (6) from the skin of a leper (subcutaneous fat-layer); (7) from the mesentery of a nursing mouse; (8 & 9) from the mesentery of a mouse found nearly dead of starvation in an empty jar; (10) from the mesentery of a rat; (11) from the mesentery of a young rat weaned a week previously by its mother, which had brought it into a semi-starved condition, from which it had recovered; and (12) from the broad ligament of the liver of a rat. All illustrating different stages of development and retrogression of the fat-cell.

[Preparations were variously treated:—(1), (3), (7), (8), (11), and (12), silver and pyrogallate of iron; (2), (4), and (10), silver, osmic acid, and logwood; (5) silver and logwood; (6) blood-vessels injected first with silver, then with carmine gelatine, and section afterwards treated with osmic acid, picro-carminate of ammonia, and indigo; (9) silver, picro-carminate of ammonia, and osmic acid.

Mounted (5) in varnish, the others in glycerin.]

Mr. Beck:—New binocular Microscope with swinging bar for condenser, mirror, and lamp, and with improved movements.

Mr. Parker:—Five slides illustrating his paper, viz.: (1) *Scyllarus*, newly hatched Phyllosoma larva. (2) *Daphnia*, entire and dissected, showing structure of heart. (3) *Asellus*, mouth parts and abdominal appendages. (4) *Blatta*, salivary gland and Malpighian tubules. (5) *Chara*, longitudinal sections of terminal bud.

Mr. J. Mayall:—Tolles' illuminating traverse lens.

Mr. Stephenson:—New $\frac{1}{8}$ objective (by Zeiss) on the homogeneous immersion system (shown on Podura).

Mr. Crisp:—(1) A similar objective. (2) Dr. Seiler's mechanical microtome. (3) Two forms of mounting a hemispherical lens for immersion illumination (by Messrs. Ross), one enabling the lens to be

approximated more or less to the slide. (3) The Weber slide (see p. 55). (4) Small form of Dr. Woodward's prism (see vol. i. p. 246). (5) Stephenson's erecting binocular, with improved method of substituting the polarizing plane for the silvered reflector by the rotation of a screw, also with removable body for ready conversion into a monocular, rotating binocular body for the use of two observers, mirror with special movements, &c. (6) The first parabolic illuminator made by Mr. Wenham (in 1856.) (7) Slide of crystallized gold (see p. 193), (lent by Messrs. Beck).

New Fellows.—The following were elected Fellows of the Society:—The Right Hon. Lord Justice Bramwell, Messrs. A. M. Bremner, T. M. Harvey, T. W. Knight, P. Pochin, G. D. Sawyer, and R. Woodall. *Honorary Fellows.*—Professors P. Harting, of Utrecht; T. Schwann, of Liège; and Hamilton L. Smith, of Geneva, N.Y., U.S.

WALTER W. REEVES,
Assist.-Secretary.

Vol. II. No. 3.]

MAY, 1879.

[To Non-Fellows,
Price 3s.

JOURNAL
OF THE
ROYAL
MICROSCOPICAL SOCIETY;
CONTAINING ITS
TRANSACTIONS AND PROCEEDINGS,
AND OTHER INFORMATION AS TO
INVERTEBRATA AND CRYPTOGAMIA,
EMBRYOLOGY, HISTOLOGY, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by
FRANK CRISP, LL.B., B.A., F.L.S.,
ONE OF THE SECRETARIES OF THE SOCIETY.



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JOURNAL

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ROYAL MICROSCOPICAL SOCIETY.

VOL. II. No. 3.

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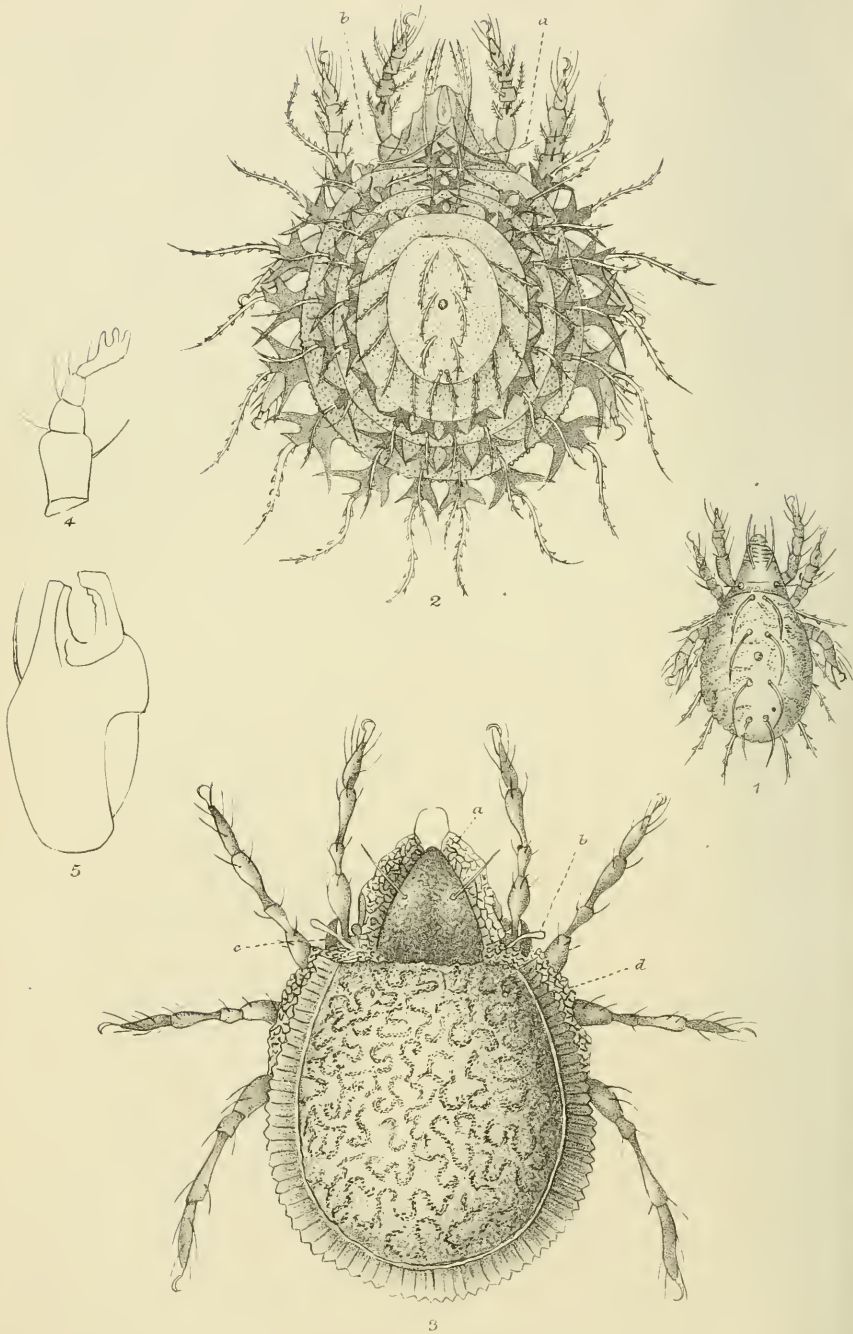
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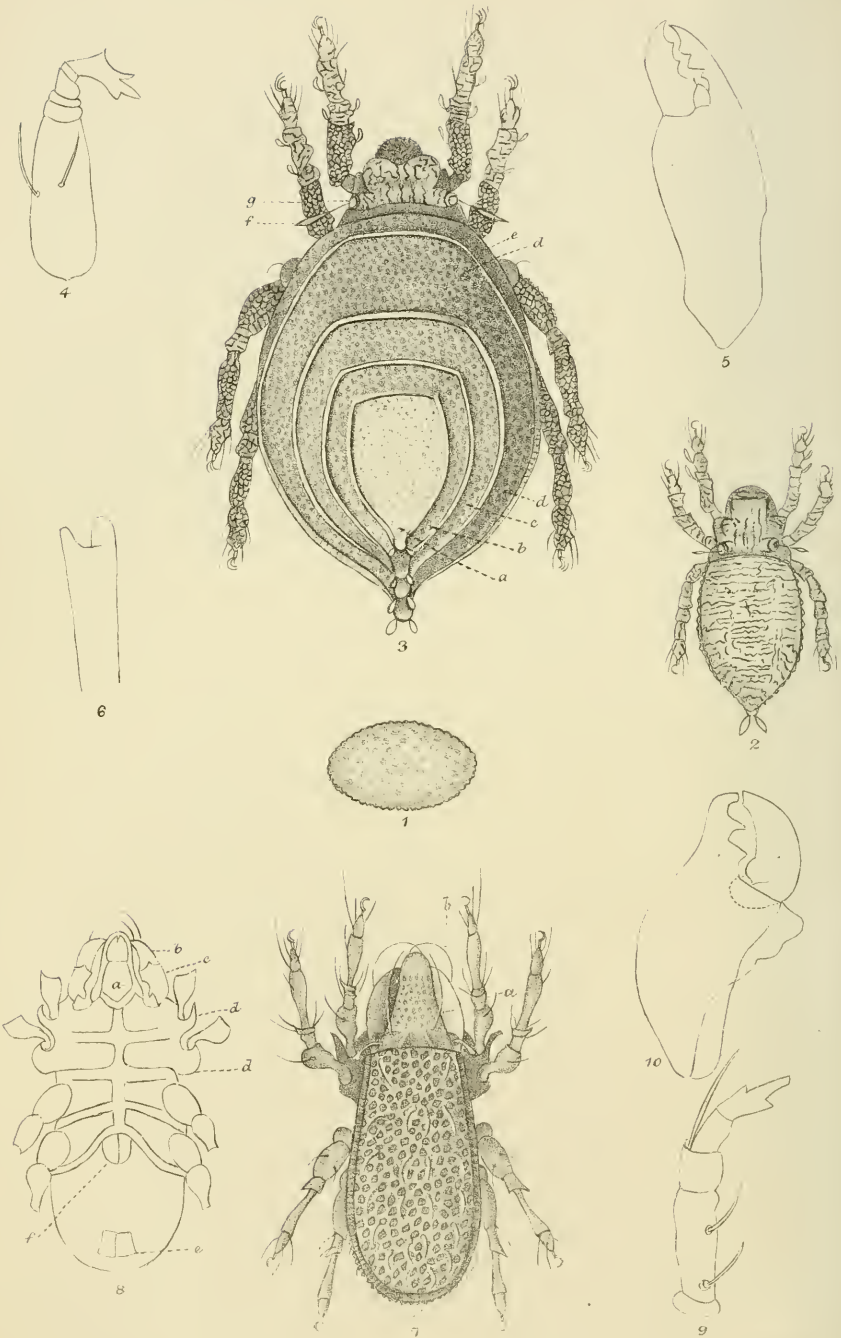


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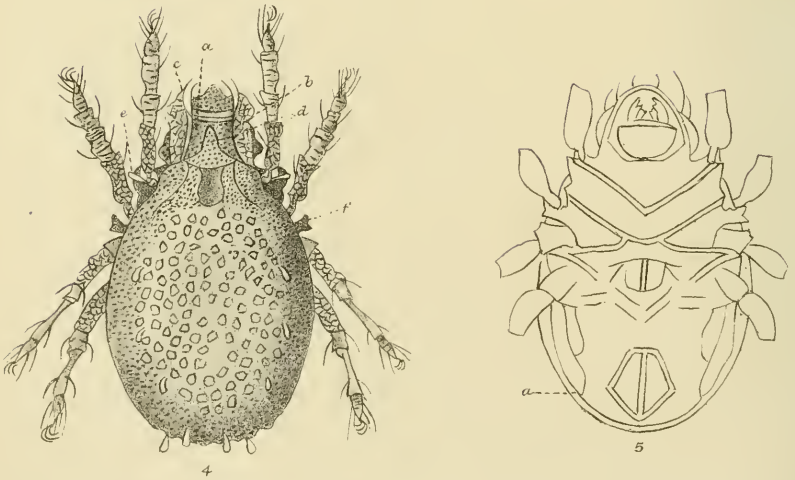
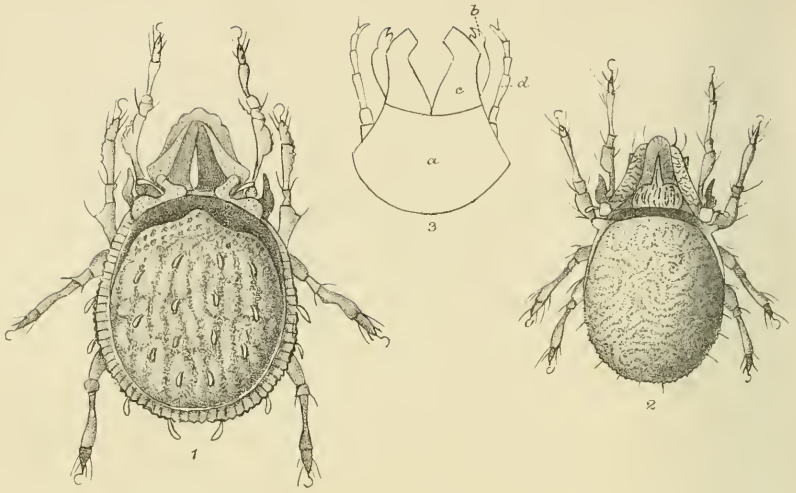




Adams

Adams

Neothrus theleproctus 1 6
Tedeocranus elongatus 7-10.



A. Michael adnasc. uel.

West. Newman & Co. lith.

Tegeocranus coriaceus, 1.
 „ labyrinthicus 2, 3.
 Scutovertex sculptus 4-3

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

MAY, 1879.

TRANSACTIONS OF THE SOCIETY.

XII.—*A Contribution to the knowledge of British Oribatidæ.*

By A. D. MICHAEL, F.R.M.S., with the assistance of C. F. GEORGE,
M.R.C.S.E. (of Kirton Lindsey).

(Read before the SOCIETY, March 12th, 1879.)

PLATES IX., X., AND XI.

AMONGST the *Acarina* are various groups which have received little attention in England, but, probably, there is not any family that has met with more neglect than the *Oribatidæ*, or beetle mites.

The common *Damæus geniculatus* is well known, and is mentioned by Curtis,* who discusses whether it is injurious to vegetation. I have seen a print, cut from some work published in 1800, inappropriately called the “Wandering mite,” which is evidently one of the *Oribatidæ*, probably a *Notaspis*. Johnston† mentions a *Carabodes nitens* in Berwickshire, but I doubt it being possible to identify it, although it is evidently one of the *Oribatidæ*;

DESCRIPTION OF PLATES.

PLATE IX.

- | | | | |
|----------|---------------------------|--------|---|
| FIG. 1.— | <i>Tegeocranus latus.</i> | Larva. | |
| „ 2.— | „ | „ | Nymph full grown. The central ellipse on the back is the cast dorsal skin of the larva, the two next rings are the similar cast skins of the nymph in its earlier stages. <i>a</i> , stigmatic hair seen sideways; <i>b</i> , the other similar hair seen edgewise. |
| „ 3.— | „ | „ | Mature (perfect) creature × 65. <i>a</i> , wing-like expansions of the cephalothorax; <i>b</i> , stigmatic hairs; <i>c</i> , projection of the sternal plate cleft for the insertion of the first pair of legs; <i>d</i> , projecting lateral ridge (at a lower level than the dorsal plate), forming a protection to the first and second pairs of legs when they are folded up. |
| „ 4.— | „ | „ | Palpus (copied from Nicolet). |
| „ 5.— | „ | „ | Mandible „ „ |

* ‘Farm Insects.’

† ‘Hist. Berwickshire Nat. Field Club,’ vol. iii. p. 113.

some parts of his description must be errors, while other necessary particulars are omitted.

The occurrence of some Hoplophora has been noticed by Mr. George,* and there may be other flying notices. I am not aware that anyone has attempted to search out and put on record the species found in this country. The late Andrew Murray† simply notices one species in each of Nicolet's genera, remarking that many of them might probably be found here if properly looked for.

This neglect cannot arise from lack of objects of interest, as anyone paying attention to them will soon ascertain. I commenced collecting and investigating them last spring; while so engaged I accidentally ascertained that Mr. C. F. George, of

PLATE X.

FIG. 1.—*Nothrus theleproctus*. Egg.

" 2.— " " Larva.

" 3.— " " Mature creature $\times 65$. *a*, cast dorsal skin of larva; *b*, ditto of nymph (first change); *c*, ditto of ditto (second change); *d*, ditto of ditto (third change); *e*, back of perfect creature; *f*, stigmatic hair; *g*, stigmata.

" 4.— " " Palpus $\times 300$.

" 5.— " " Mandible $\times 300$.

" 6.— " " Maxilla $\times 300$.

" 7.—*Tegeocranus elongatus*. *a*, hairs of the vertex; *b*, hairs proceeding from edge of wing-like expansion of cephalothorax and crossing in front of the rostrum.

" 8.— " " Under side. *a*, labium; *b*, wing-like expansion of cephalothorax; *c*, shorter ditto lower in level; *d*, projection of sternal plate indented for insertion of first and second pairs of legs; *e*, anal plates; *f*, genital plates.

" 9.— " " Palpus $\times 300$.

" 10.— " " Mandible $\times 300$.

PLATE XI.

FIG. 1.—*Tegeocranus coriaceus* $\times 65$.

" 2.—*Tegeocranus labyrinthicus* $\times 65$.

" 3.— " " Mouth organs. *a*, labium; *b*, mandible partly showing from below the maxilla; *c*, maxilla; *d*, palpus.

" 4.—*Scutovortex sculptus* $\times 65$. *a*, tectum; *b*, wing of ditto; *c*, terminal hair of same wing; *d*, projecting point of dorsal plate; behind is seen the clearer depressed area arising from the absence or thinness of the chitine; *e*, stigmatic hair; *f*, projection from sternal plate between third and fourth pairs of legs.

" 5.— " " Under side $\times 65$. *a*, reflexed edge of the dorsal plate seen embracing the sternal plate.

" 6.— " " Fourth and fifth joints and tarsus of first pair of legs, showing projection of fourth joint $\times 300$.

" 7.— " " Palpus $\times 300$.

" 8.— " " Mandible $\times 300$.

" 9.— " " End of a maxilla.

* 'Science-Gossip,' 1877, p. 205.

† 'Economic Entomology.'

Kirton Lindsey, was doing the same thing. I communicated to him that I was preparing a paper on the subject to be submitted to this Society, and he at once placed his observations and specimens at my disposal, a piece of generosity which I desire most gratefully to acknowledge. I have endeavoured to mention his observations as they occur. My searches have been made during the past twelve months, near Tamworth, in Warwickshire; at Wandsworth, in Surrey; Epping Forest; and the shores of Loch Maree and Loch Ewe, in the Ross-shire Highlands; Epping being more thoroughly hunted than the other places.

Mr. George has collected entirely at Kirton Lindsey, in Lincolnshire.

I am aware that the 'Transactions' of this Society are not the place to monograph a family of British Arachnida, although of microscopic size, nor would the number of plates which can fairly accompany a paper like this enable one to do so, even if twelve months' searching were sufficient for the purpose, which is far from being the case; but I have thought that our observations might possibly be of sufficient interest, and would contain sufficient entirely new matter, to excuse my occupying a little of your time.

The plan I have followed is to give first a short summary of the principal distinctive characters of the family and a reference to the leading foreign bibliography (there is not any English); then such observations as to general matters as I have to submit; and, finally, to give a list of the species found, with any observations as to each species which I have thought new and interesting, and also details of such larvæ and nymphs, which had not been before observed, as I have been able to rear, so as to be certain what species they belonged to.

Distinctive Characters of the Family.

Taking for granted the distinctions common to all Acarina, the Oribatidæ are formed into a strongly marked group by the following characters, viz.:—

1. A hard chitinous exo-skeleton, as in a beetle; it is this resemblance that has given origin to the name of beetle mites. The chitine covers every external part of the perfect creature, and is very hard, but extremely brittle and entirely devoid of elasticity, so that on any pressure it breaks into fragments; it is always black or brown.

2. The form of the stigmatic and tracheal system, which is peculiar, consisting of two hard, more or less projecting, stigmata, of a short tubular or trumpet shape, one at each side of the cephalothorax near the juncture with the abdomen (but varying a little in position); below each of the stigmata is an air sac, and some long filiform tracheæ supplying the body, and from inside

the edge of each of the stigmata always proceeds a hair, the shape of which varies with the species; it is known as the protecting hair, and I have a few words to say about it hereafter.

3. The legs have invariably five joints, and are terminated by either one or three claws, without sucker or caroncle.

4. The palpi have five joints.

5. The ventral surface is pierced by three openings, the first formed anteriorly by the overhanging of the dorsal surface and posteriorly by a deep indentation of the sternal plate; through this opening the palpi and organs of the mouth are protruded (or withdrawn at will), and in most species the orifice can be almost entirely closed by the *labium*. The second orifice is rhomboidal or oval, and is always closed by two chitinous plates like folding doors, which open to afford a passage to the reproductive organs. The third orifice is the anal, and is similar in shape to the genital, and is closed by similar plates, which are usually larger than the genital ones.

6. There never are any visible eyes.

Bibliography.

I have not attempted to give an exhaustive bibliography, but only referred to the few authors whose works are of importance, and a reference to which is almost necessary for the latter part of this paper; these I have arranged, not in order of date, but, to some extent, in order of importance.

The first place must be assigned to Nicolet's monograph of the Oribatidæ in the neighbourhood of Paris,* an admirable work, beautifully illustrated, clear, and distinct. I have followed his arrangement, introducing such species as Nicolet did not find, in what appear to me to be their respective proper places; but, while doing so, I may say that I probably might not quite adhere to this system were I myself writing a monograph, as, although it has the advantage of great distinctness, it seems to me highly artificial, and I doubt if one or two of the distinctions can be supported, for instance, the great stress laid on the difference between homodactyl and heterodactyl claws; I doubt whether any truly homodactyl claws exist in the family, it seems to me probably more a question of degree.

C. L. Koch, in his great work,† has described and figured an immense number of species and given their classification in a subsequent work; ‡ these two books form a vast storehouse of knowledge relative to the Acarina, and a monument of human industry; they are an absolute necessity to the apterologist, but it must be

* 'Archives du Museum,' 1855, t. 7.

† 'Deutschland's Crustaceen,' &c.

‡ 'Uebersicht des Arachnidensystems.'

confessed that the descriptions and figures are often scarcely sufficient for identification, and that every specimen which presents the smallest difference is given as a distinct species; often the male, female, and nymph, and even the nymph after each change of skin, are given as distinct species, producing confusion. Koch had scarcely a genius for classification; his genus *Nothrus* for instance is a strange collection of heterogeneous creatures. I should think it my fault that several of his genera do not convey any clear idea to my mind, if such men as Nicolet, Murray, and Mégnin, had not said the same thing before me.

Hermann* has described and figured several species in a manner, like all his work, most admirable, considering the date, but not always sufficient for modern requirements.

Dugès,† in his excellent papers on the Acarina, treats of the Oribatidæ, but more shortly than of the other families.

Ed. Claparède‡ gives some highly interesting observations of the transformations of *Hoplophora*, &c.

There are numerous other authors, such as Gervais,§ De Geer,|| Latreille,¶ Lucas,** Thorell,†† &c., whose works contain valuable information.

General Observations.

It appears to be the result of modern research that the *Oribatidæ* are the only family of Acarina no species of which is ever parasitic at any stage of its existence; the various *Sarcoptidæ* and some others of the true *Acari* are always parasitic, the *Ixodidæ* partly so; the *Gamasinæ* and many of the *Hydrachnidæ* are parasitic during the nymph stage; the *Trombididæ* during the curious hypopial nymph stage; †† and Mégnin has lately shown that even some of the *Cheyleti* are in a sense parasitic, §§ but it never occurs amongst the *Oribatidæ*.

It seems to me that the numerous contrivances for protecting the legs in the *Oribatidæ* have not been sufficiently noticed, nor their purpose understood; the animals are all vegetable feeders, and are slow and cannot escape from enemies by running; they are not provided with weapons of defence, but are furnished with a very hard shell, and their safety consists in trusting to it and "shamming dead": this would be useless if their legs were exposed. Everyone who has seen a predatory mite seize a victim, knows that it usually

* 'Mémoire Aptérologique,' Strasbourg, 1804.

† 'Annales des Sciences Naturelles,' 1834.

‡ 'Studien über die Acariden,' Leipzig, 1868.

§ 'Histoire Nat. des Aptères,' Paris, 1847.

|| 'Mémoires pour servir à l'Hist. Nat. des Insectes,' Stockholm, 1778.

¶ 'Hist. Nat. des Crustacés et des Insectes,' Paris, An XII.

** 'Exploration Scientifique de l'Algérie.'

†† 'Oefv. Sv. Ak.,' 28, 695. (1871.)

‡‡ Mégnin, 'Journal de l'Anatomic,' 1874.

§§ Ibid., 1878.

does so by the leg, and although a *cheyletus* might not be able to make much impression on one of the *Oribatidæ*, yet a *chelifer* would probably be more successful. This protection of the legs is carried to its highest perfection in *Hoplophora*, where the legs are short and project on the ventral surface near the hinder part of the cephalothorax, which is only united to the abdomen by an articulation allowing the former to shut down on the ventral surface of the latter, the hood which covers the cephalothorax forming a hard, close, box over the legs (which have been retracted), and the various parts of the mouth &c., so that (the genital and anal plates being closed) one unbroken, hard surface is presented to the enemy, and it is amusing to watch the cephalothorax being raised and the legs cautiously making their appearance when the danger is supposed to be over.

In the genera *Pelops* and *Oribata* there is a chitinous flexible wing-like expansion to the fore part of the edge of the abdomen, projecting a little forward; when any alarm occurs, the legs are neatly folded against the body and this wing-like cover closed over them, making the whole as snug and as slippery as possible.

In the genera *Tegeocranus*, *Notaspis*, &c., the sternal plate or the lower edge of the dorsal bears several strong projecting ridges, leaving deep depressions between them into which the legs, when folded up, exactly fit; the leg generally being bent at the middle joint, and one ridge lying within the flexure, so that the whole leg can lie upon the under surface of the body, and be almost as well protected as by the former methods.

In *Eremæus*, &c., the coxæ of the first and second pairs of legs are set in deep indentations of the sternal plate open above and below with strong projections between. I have observed that this arrangement not only protects the leg, but also enables the creature to raise it right over its back, which is useful to it, enabling it to right itself when it falls on its back, as it frequently does.

While treating of the modes in which *Oribatidæ* protect themselves, I may call attention to the singular habit which several species, and the nymphs of others, have, of coating themselves with extraneous matter; this is attained in various ways. In most members of the genus *Nothrus* the back is concave, and dirt is piled in the concavity; in *Damæus geniculatus* and *D. clavipes*, the back, particularly in the nymphs, is provided with numerous long hairs; it is by some means plastered with mud, which adheres to the hairs, and indeed, it is not easy to get it off without destroying the creature. In *Damæus papillipes* and *D. verticillipes* a different mode is seen; the whole creature, including legs, and often each individual hair, is thickly coated with white dust, so that the animal looks as if it had been rolled in plaster of Paris.

Another strange habit of many of the *Oribatidæ*, which also is probably protective, consists in carrying on the back a pile, or

shield, of the dorsal parts of the cast skins from the earlier stages, which, adhering closely to the back of the perfect creature, or the nymphs, as the case may be, give it the appearance of being a totally different shape from what it is; this is seen in *Damæus verticillipes*, *Nothrus theleproctus*, and others, and is admirably shown in the nymph of *Tegeocranus latus*.

Before closing these general observations, I should mention habitat: *Damæus geniculatus* and *D. clavipes*, the genus *Hoplophora*, and some others, live chiefly under bark, and more especially in decaying wood; some of the genus *Oribata* may be found on the leaves of trees, but the greater number of the *Oribatidæ* are more or less solitary, and live either in moss, preferring that growing on the lower parts of trees, or under stones, but I have found them most numerous upon some of the parasitic fungi which grow out from the stems of trees in woods; this is specially the case with *Tegeocranus*. The moss must be damp but not wet; I have found but few when it was either very wet or very dry.

Transformations.

I consider that the most interesting work that I have done for this paper in this department is in tracing the transformations and life-history of *Tegeocranus latus*, the larva and nymph of which have not, to my knowledge, been before observed, and are remarkable creatures; indeed, I fancy that those who look at the nymph and perfect creature will agree with me that no more singular transformation exists amongst the *Acarina*.

The mode of watching transformations which I have adopted has been much the same as I employed in breeding *Cheyleti* and *Glyciphagi*; I have succeeded better with a simple glass ring cell with a loose thin cover kept on by a clip, than with more elaborate or more perfect apparatus; into each cell a small piece of moss or decayed wood was placed, having been first carefully examined under the Microscope to see that it did not contain mites or ova, then the mites to be studied were carefully picked in one by one, only one sort being placed in a cell, and only a few specimens; each cell was examined every day, and air and moisture given when necessary. When I was fortunate enough to find a captive commencing its transformation, the whole apparatus was transferred to the stage of the Microscope and the change watched; I have usually kept some twenty-five to thirty of these breeding cages going through the past summer, but have found great difficulty in keeping some species, and have not succeeded in getting them to lay eggs, although I have bred through from eggs and larvæ which I have found.*

The escape of the larva from the egg I have watched in the

* Since this paper has been lodged with the Society I have succeeded in the case of *Tegeocranus coriaceus*.

case of *Damæus geniculatus* and *D. clavipes*; the egg in these species is an oval somewhat flattened on two sides; it is brown, but round the edge runs a lighter band where it seems that the shell is thinner; along this band the shell breaks, finally separating into two boat-like pieces; it breaks first at the small end, which contains the head, or rather rostrum, of the larva; the long legs are doubly folded upon the under side of the body; the long hairs of the back lie flat and pointing straight backwards; the front part of the cephalothorax, when I watched the process, protruded first; it was slowly followed by the anterior pair of legs; then the whole cephalothorax and the second pair of legs gradually made their appearance, the progress being very slow; a long delay then seemed to take place, during which the various parts stiffened and assumed their normal positions, the hairs becoming more or less perpendicular; the hinder pair of legs (for the larva is hexapod) remained in the shell until the last, and pushing against the inside of one half, while the back rested in the other, seemed slowly to open it. As the different parts emerged, everything movable was kept continually moving, a strange sight in these slow and lazy creatures; the legs were worked in all directions, and it was amusing to watch the parts of the mouth constantly going; the lobster-like mandibles, usually so difficult to see, were protruded and retracted independently, and kept snapping continually. The escape from the egg lasted six or eight hours; I cannot say if it takes as long in a state of nature.

The change from the larval to the nymph stage does not offer any sufficient difference from that from nymph to perfect creature to make it necessary to describe it. Claparède (*loc. cit.*) in his admirable papers on the Acarina describes how he watched the transformations of water mites of the genus *Atax*, and found that, on the change from larva to nymph and from nymph to perfect creature, it was not a mere change of skin that was effected, but that the whole creature dissolved, the new creature being formed from the material, the skin of the old creature coming away and leaving an egg-shaped body, long before the new creature was fully developed. More lately Mégnin has traced the development of the *Sarcoptidæ* and *Gamasinæ* with precisely the same result as Claparède.

I am not aware that anyone has previously watched the *Oribatidæ*, but my own observations upon them certainly lead me to the same conclusion. It must not, however, be forgotten that Dugès, in his excellent chapter on the *Hydrachnidæ*, the transformations of which he watched, expresses a contrary opinion, and says that the creature retires within its own skin as within a bag, and that the parts are modified rather than newly formed; and he says, in support of this view, that mutilated parts do not reappear. Probably the real divergence of opinion is not so great as it seems,

as Dugès describes a partial dissolution, although he thinks that the legs, for instance, are formed at the expense of the old legs instead of from the general mass of the body, which Mégnin denies, and which does not coincide with my own opinion.

As a rule, the integument of the larva and nymph of the *Oribatidæ* is soft and light-coloured; in the perfect creature it is hard and dark; this is subject to the modification hereafter mentioned.

In the final change, which I have carefully watched in the case of *Tegeocranus latus* and *Oribata punctata*, the adult nymph gradually becomes inert, creeps into a hole or sheltered place, and seems to me to fix its claws firmly in whatever it is resting on; it then becomes motionless and to all appearance dead. In one or two instances with *Tegeocranus latus* I carefully cut out the minute piece it was fixed on, and placed it where I could see it better, preserving the same conditions; in this state it remained for about a fortnight without any signs of life, at the end of that time the skin got rapidly darker, and about twelve hours after, the skin split at the posterior edge (the creature being a flat oval) and the anal margin of the body of the adult slowly appeared by the skin shrinking from it; this splitting along the edge and shrinking of the skin imperceptibly proceeded from behind forward, the creature remaining motionless. After five or six hours one could see that the parts of the perfect creature were formed independently of the similar parts of the nymph, the legs, for instance, not being formed within the old legs which were stretched out, but being folded on the body and securely packed within the depressions between the protecting ridges before mentioned. When the skin had split sufficiently far, the perfect creature at last moved, slowly unfolded its legs, withdrew its cephalothorax from the fore part of the old skin, like a finger from a glove, and walked off, leaving the old skin with outstretched legs in the same position it had occupied for a fortnight.

With regard to the discovery of the nymph of *Tegeocranus latus*, one day, when searching for *Oribatidæ* amongst moss on an old tree stump in Epping Forest, I found between the moss and the wood a creature new to me. On examining it under the Microscope, I found that it belonged to the family I wanted, but was so strange and *bizarre* that I hardly knew how to class it; it was a flat oval, the edge cut into great triple serrations difficult to describe, and from each serration sprang a long thick spine, bent into an elegant double curve and armed with short thorns, while ring within ring on the back were the cast dorsal skins of the earlier stages, each bearing its own serrations and spines, so that the whole dorsal surface was a *chevaux-de-frise*, the ventral surface being pressed close to the wood. At once there arose the question, was this

strange organism a nymph or a perfect form? As before stated, the nymphs are usually soft and light-coloured, the perfect form hard and dark, but this is modified by the fact that with each change of skin the nymph becomes somewhat harder and darker, so that the nymph of a species, the adult of which is very black and hard, as in the *Tegeocrani*, becomes, before the final change, as dark and hard as some other species, e.g. many of the genera *Nothrus* and *Eremæus*, are after it. To decide this I searched and at last obtained several more living specimens of various ages; some appeared to show eggs, which strongly favoured the idea that it was an adult, as the appearance somewhat indicated. I also obtained some cast skins. While in doubt, I received a letter from Mr. George, with a rough sketch of something he had found, which was manifestly my creature; he had only one specimen, and, like myself, was in doubt whether it was a nymph or adult; his individual showed eggs, which pointed to the adult theory. I kept all I could get alive for some weeks without any indication of a more perfect stage; still I could not rid myself of the idea that it was only a nymph, my reasons being, first, that it bore on its back the dorsal parts of the larval and two pupal skins only, and in *Nothrus theleproctus* and others that I had watched, the nymph had cast its skin twice *before* the change to the perfect form; secondly, that I found what seemed to be a discarded skin as perfect as the animal I had alive; if it were, something must have come out of it; thirdly, I had one dead specimen which seemed to show something forming below the skin. I kept my breeding cages going until the last day of my stay in Epping Forest, without success; but the evening before I left, one became much darker, and the morning I was leaving for the Highlands the skin of the nymph split, and *Tegeocranus latus* emerged as before described.

I relate this to show the necessity for caution in judging whether a newly found mite is a nymph or perfect creature, and how excusable it was in Koch to figure them often as separate species, writing when he did.

I have mentioned above that some specimens apparently contain eggs; it is quite possible that Mr. George and I were mistaken, and that they were not eggs; their being so seems inconsistent with the dissolution and reformation of the animal in the change from nymph to imago; but it must be remembered that C. Robin has shown* that the male *Dermaleichi* copulate, not with the final form of female, but with an intermediate form, which in appearance almost exactly resembles the nymph; and the same author and Mégnin have demonstrated that this intermediate form, which they call "*femelle accouplée*," often shows eggs, although not provided with any vulva of gestation, which only appears in the final form of female. This

* 'Comptes Rendus,' 1868, p. 776.

is asserted by Mégnin to apply to the *Tyroglyphi*, *Glyciphagi*, *Carpoglyphi*, *Gamasinæ*, and *Trombididæ*: it would therefore from analogy be likely to occur in the *Oribatidæ*, although I am not aware that it has been observed, and if so these may well have been *femelles accouplées*, or, as I should call them, nubile females.

I was curious to see how the casting of the skin was so managed as to leave the pile of the dorsal parts on the back, and thought this a favourable species to observe. I did not find any difficulty in doing so. The skin splits along the edge, commencing at the rear as before described, until it reaches the rear of the vertex; then the split, instead of continuing round the edge of the cephalothorax, goes across the back, and the creature backs out of the fore and lower part of the old skin, keeping the dorsal, or rather dorso-abdominal, portion still on its back. There does not appear to me to be any disintegration of the creature in mere changes of skin. Every larva or nymph which I have figured or mentioned I have assured myself of by breeding it to the perfect form.

Organs of Special Sense.

As before stated, *Oribatidæ* have not any visible eyes that have yet been discovered. I have before expressed an opinion that others of the *Acarina* whose condition is similar have some sense of sight, or are, at all events, sensitive to light, which most of them dislike; in order to utilize this dislike in tracing sight further if possible, I placed a living *Eremæus oblongus*, one of the most lively of the *Oribatidæ*, in a large glass cell, putting a piece of moss in the middle. I then arranged the Microscope so that the sun fell on the stage, but placed a dark screen to throw it into shadow. I then placed the cell on the stage, and watched until the mite was on the raised edge of the cell, where they generally like to be. I then suddenly removed the screen; the mite did not wander vaguely about, but came down from the edge, and crossed the bottom of the cell in a straight line for the moss, under which he got; the same experiment repeated once or twice had the same result. I leave my hearers to decide whether this does not indicate some sense of sight.

What are called the protecting hairs of the stigmata were once supposed to be organs of vision; this was evidently incorrect, and is long since exploded. The high authority of Nicolet and others is in favour of their being simply protecting hairs. Doubtless the contrivances by which stigmata and spiracles are protected are various, but it is generally apparent that they are admirably suited to their purpose. It is not, however, at all clear how these hairs can be of any protection; there is never more than one on each side; they cannot exclude dust, &c., because whatever the form of the hair, only the fine part is near the stigmatic opening, and they are too

soft and flexible to be effective defensive weapons ; whereas the joints of the legs are often defended by powerful spikes ; the clubbed ends borne by so many of these hairs are often hollow or cellular, and it seems possible that they may be eventually found to be the seats of some special sense (as hearing or smell) instead of being merely protective.

Summary.

The results of the season's work may be summarized thus: forty-four species have been found, of which I believe that only three or four have been previously recorded in Britain. The total number which rewarded Nicolet's admirable and prolonged search in France was fifty-six.

Of these forty-four species, I believe three to be entirely new to science, viz. Nos. 21, 38, 39.

Two species have, to my knowledge, been found in France, Germany, and Sweden, viz. Nos. 2 and 32.

Eighteen species in France and Germany, viz. Nos. 3, 5, 13, 15, 17, 22, 24, 25, 26, 27, 29, 31, 32, 33, 36, 40, 43, 44.

Fourteen species in France only, viz. Nos. 1, 4, 6, 8, 10, 11, 12, 14, 16, 18, 23, 28, 41, 42.

Six species in Germany only, viz. Nos. 9, 19, 20, 34, 35, 37. I include Switzerland with Germany for this purpose.

One species in France and Algeria, viz. No. 7 ; probably they would have been found elsewhere if properly looked for, as two or three have also been found in Spitzbergen.

The life-history of two sorts, *Tegeocranus latus* and *Nothrus theleproctus*, has been traced for the first time, and others confirmed, in addition to the above observations on habits, &c.

PART II.

In this part the following rules have been observed :—

Species which have been described by Nicolet are not redescribed, but those given by Koch or others are described where the description of the author referred to does not seem to me sufficient for certain identification. Species believed to be new are described.

If there be fair grounds for believing that a species found by me is identical with, or a slight variety of, one known by me to have been already described, that species is adopted (defining it) instead of giving a new name, although the former description may not be sufficient for actual certainty.

With regard to naming the joints of the legs, *Robin* is followed, not *Nicolet* ; this I have done, regarding Robin as the more eminent anatomist as well as the more modern authority. It must be remembered that their views are entirely different, e. g. the *trochanter* of

Robin is the *femoral* of Nicolet; in other respects, Nicolet's names for parts of the exo-skeleton are preserved.

The sexes are not described separately, their external differences being usually so slight that it is unnecessary.

All measurements are in decimals of a millimetre.

A reference to Koch without naming the work means his 'Deutschland's Crustaceen Miriapoden und Arachniden,' Regensburg, 1841.

In the Plates, all whole creatures are drawn $\times 65$, most details are $\times 300$.

All the figures are drawn from nature, except Figures 4 and 5, Plate IX.

All whole creatures were drawn in the first instance with the camera.

GENUS PELOPS.

1. PELOPS FARINOSUS. Nic.

Nic. 425.

Found at Kirton Lindsey by Mr. George, and by me at Epping Forest and Loch Maree; not uncommon.

The English specimens have not the round spot in the centre of the abdomen figured by Nicolet, nor the two spatulate hairs one on each side of it, and the stigmata are not as deeply sunk as in Nicolet's drawing. It might be said these differences are sufficient to constitute a species, but in the absence of further evidence, I prefer considering them as showing a variety only.

GENUS ORIBATA.

2. ORIBATA ALATA. Herm.

Notaspis alatus. Hermann, 'Mémoire Aptérologique.'

" " Dugès, 3rd Mémoire, 47.

Acarus coleoptratus. Linnæus, 2nd edn. No., 1973.

Zetes dorsalis. Koch, fasc. 2, pl. 14.

Oribata alata. Gervais, 'Histoire Nat. des Aptères,' vol. iii. 258.

" " Nicolet, 'Hist. Nat. des Acariens,' &c., 431.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

3. ORIBATA LUCASH. Nic.

Nic. 432.

Zetes lævigatus. Koch, fasc. 3, pl. 8.

Found at Epping Forest.

4. ORIBATA NITENS. Nic.

Nic. 433.

Found at Epping Forest.

5. ORIBATA PUNCTATA. Nic.

Oribates ovalis. Koch, fasc. 3, pl. 5.*Oribata punctata*. Nic. 434.

Nymph and perfect creature found everywhere; common. I have bred this creature through its changes, and can confirm the correctness of Nicolet's figure of the nymph.

I use Nicolet's name of *punctata* instead of Koch's earlier name of *ovalis*, because the latter author gives an *Oribates ovalis* and an *Oribates ovatus*, which might cause confusion.

6. ORIBATA PIRIFORMIS. Nic.

Nic. 436.

Found at Epping Forest and Loch Maree; scarce.

In the English specimens the stigmatic hairs are more strongly and suddenly clubbed than in Nicolet's figure.

7. ORIBATA LAPIDARIA. Lucas.

Lucas, 'Exploration scientifique de l'Algérie,' 318.

Nic. 439.

Found on trees everywhere; very common.

I think it possible that this and *Oribata globula*, Nic., may turn out to be one species; certainly some of what I have found are forms intermediate between the two types.

8. ORIBATA EDWARDSII. Nic.

Nic. 438.

Found at Loch Maree.

9. ORIBATA MOLLIKOMUS. Koch.

Oribates mollicomus. Koch, fasc. 30, pl. 20.

Oribata notata. Thörell, 'Oefvers. af Kongl. Vet.-Akad.' 1871, 695.

I have found three or four specimens of what appears to be this creature at Epping Forest. It is quite possible that it is not truly a species, but only another variety of *Oribates setosus* (Koch, fasc. 30, pl. 19; Nic. 436); in which case it is better that the latter name should stand as Nicolet has adopted it; but the reasons against this are, Firstly, in my specimens the wings of the tectum are not joined by any transverse ridge—a distinction by no means unimportant, as Nicolet relies greatly on this ridge; Secondly, my specimens are much smaller than Nicolet's; Thirdly, the rows of hairs on the back are much wider apart from row to row, and contain fewer hairs than in Nicolet's figure; Fourthly, the coxæ and tro-

chanters of the first two pairs of legs in my specimens are prolonged at the edge into thin flat blades not mentioned by Nicolet.

I think this is probably the species recorded by Thörell as found at Bell's Sound, Spitzbergen.

10. ORIBATA GLOBULA. Nic.

Nic. 439.

One specimen found at Epping Forest.

GENUS LEIOSOMA.

11. LEIOSOMA NITENS. Gervais.

Oribata nitens. Gervais, in Walckenaer, vol. iii. p. 259.

Leiosoma nitens. Nic. 441.

Found by Mr. George at Kirton Lindsey.

12. LEIOSOMA SIMILIS. Nic.

Nic. 442.

Everywhere; common.

In English specimens the central point of the tectum is not as sharp as in Nicolet's figure, but is more square.

13. LEIOSOMA OVATA. Koch.

Leiosoma lativentris. Nic. 443.

Oribates ovatus. Koch, fasc. 30, pl. 24.

Found at Epping Forest and Loch Maree.

The English specimens seem much smaller than the size given by Nicolet (.55 mm. instead of .75 mm.), but as they agree in all other respects I do not think this sufficient to found a species.

14. LEIOSOMA MICROCEPHALA. Nic.

Nic. 443.

Found at Epping Forest; scarce.

GENUS CEPHEUS.

15. CEPHEUS TEGEOCRANUS. Herm. 93.

Notaspis tegeocranus. Gervais, in Walck. iii. 258.

Cepheus vulgaris. Nic. 445.

Found everywhere; common.

In the English specimens the rows of hairs on the abdomen are not nearly so conspicuous as they are in Nicolet's plate.

16. CEPHEUS LATUS. Nic.

Nic. 446.

Found at Epping Forest.

The English specimens have small hairs on the abdomen, not figured by Nicolet, and the anterior line of the abdomen is very slightly sinuated. I cannot help doubting whether the species is really more than a variety of *C. tegeocranus*.

GENUS NOTASPIS.

17. NOTASPIS BIPILIS. Herm.

Hermann, 95.

Nic. 448.

Oribates badius? Koch, fasc. 30, pl. 23.*Oppia cornuta.* „ „ 38, pl. 8.*Oribata bipilis.* Gervais, vol. iii. p. 259.

Found everywhere ; common.

18. NOTASPIS EXILIS. Nic.

Nic. 448.

Found everywhere ; common.

The small hairs on the abdomen figured by Nicolet are absent, or very inconspicuous, in the English specimen.

Is Nicolet's *N. tibialis* really a distinct species ?

19. NOTASPIS PILOSUS. Koch.

Zetes pilosus. Koch, fasc. 31, pl. 12.„ *pilosulus.* „ Uebersicht, 101.

Average length about .45 mm.

„ breadth „ .3 mm.

Found at Epping Forest ; scarce.

This and the next species clearly should not have been included in Koch's genus *Zetes*, which Nicolet has properly joined to *Oribata*. I have had great doubt if they are really distinct, but on the whole I think that the difference in the so-called stigmatic hairs, which are good specific distinctions in the *Oribatidæ*, the smaller size and rounder shape of the body, and the far greater development of the general dorsal hairs in this species, are sufficient to justify both being retained, subject to future investigation ; this one, at all events, should stand.

Colour red-brown, sometimes almost red. *Cephalothorax* conical, with a constriction a short distance from the front, thence it curves outwards until about the middle, whence the central portion runs nearly straight back rising to the level of the abdomen ; the lateral

portions are much lower in level, and expand into a shelf with deepish indentations for the insertion of first pair of legs and shallower ones for the second pair. *Tectum* so entirely amalgamated with *cephalothorax* that it is only shown by two strong spinose bristles standing up at its termination; two similar bristles stand up straight behind the first pair, just at the hind margin of the vertex, two shorter similar ones horizontal at the above-named constrictions; stigmata at the edge of the raised part of cephalothorax almost under the edge of the abdomen; the stigmatic hairs medium length, standing upwards and slightly outwards, filiform, about half the length, thence spatulate with blunt-pointed tips. Mandibles large and projecting.

Abdomen a short pear-shape, hinder end very round, anterior end narrow, with a rounded point projecting on to cephalothorax and joined to it on a level; a strong spike stands straight out horizontally from each edge of the dorsal plate between the second and third pairs of legs. A row of about seven very long hairs (nearly half as long as the abdomen) curved backwards round edge of each side of abdomen; six similar round hind margin lower in level, and three pairs down back more central; coxæ of first two pairs of legs hidden, those of two hind pairs conspicuous; all trochanters stout, claws large.

20. NOTASPIS LUCORUM. Koch.

Zetes lucorum. Koch, fasc. 31, pl. 18.

Average length about .67 mm., but variable breadth about .37 mm.

A creature which I believe, not without doubt, to be Koch's *lucorum*, has been found by Mr. George at Kirton Lindsey, and by me at Epping and Loch Maree; it had, however, been previously found by Mr. Underhill, of Oxford, and figured by him in the 'Notes of the Postal Microscopic Club,' December 19th, 1877. It is a very variable species, the abdomen in some specimens being considerably longer in shape than in others. The distinctions from the last species are, its larger size and more pointed abdomen, the stigmatic hairs being much shorter, and instead of being spatulate having a short filiform stalk terminated by a piriform club, so short as usually to appear a ball which hardly rises above the back, and that the dorsal hairs are much shorter.

GENUS SCUTOVERTEX.* Mihi.

This genus I have, somewhat unwillingly, originated, for a creature which has not, to my knowledge, been recorded before, and which, although bearing many resemblances to *Eremæus*, is so opposed to some of the main characteristics by which Nicolet defines

* *Scutum*, a shield, and *vertex*, the top of the head.

that genus, that it appears to me that it cannot properly be included therein.

Generic Characters.

Palpi with first joint small, second and third swollen, the second being considerably the longest; fourth and fifth joints much slighter, but fifth as long as second, and dentated on the outer edge. *Labium* broader than long, nearly straight on the anterior edge, and not covering above half the buccal opening. *Mandibles* rather long with the fixed claw not toothed. *Maxillæ* bilobed, lobes unequal. *Cephalothorax* large and conical, *having a tectum attached only by its base*, less wide than the cephalothorax, and covering part only of its length. Cephalothorax deeply indented for the reception of the coxæ of the first pair of legs, which are almost entirely hidden, those of the second pair being supported by strong projections. Legs thick and shorter than the body; all the trochanters and the coxæ of the last two pairs broad and flattened; fourth joints of the first pair of legs with a projection overhanging the fifth like *Eremæus*. Tarsi with three heterodactyle claws, the centre one being conspicuously the thickest. Abdomen longer than broad, flattened on the dorsal surface, the dorsal plate of which projects anteriorly over the cephalothorax, and may be fastened to the upper surface of the tectum, and also projects at the anterior angles (or shoulders) sheltering the stigmata, which are wide apart, set far back, and point outwards.

This genus will fall in Nicolet's first division, being tridactyle; in the first subdivision, being furnished with a tectum, and it would appear to come properly at the end of that division immediately before *Eremæus*, which latter genus it resembles in the form of the tarsi and claws, the mode of insertion of the legs, and many other particulars, while it is divided from it by the tectum, the form of the palpi and labium, the thickness of the legs, &c.

21. SCUTOVERTEX SCULPTUS. Mihi (Plate XI. Fig. 4).

Average length about .60 mm.

„ breadth „ .33 „

New Species.

Colour varying from dark red brown to black.

Cephalothorax large at the base and bluntly conical, but mostly hidden under the advancing dorsal plate of the abdomen. *Tectum* almost square, but a little longer than wide; wings of tectum raised almost perpendicularly, broadest anteriorly, and ending in long, blunt, curved points, with curved terminal hairs. A little way in front of the tectum is a round plate covering the point of the rostrum, and raised in the centre and at the edge. From below this a ridge runs along the side of the cephalothorax, ending in a

rounded elevation before reaching the first pair of legs. These are set in deep clefts of the sternum, open above, and open, but to a less extent, below. Between the second and third pairs of legs, is a long, chitinous projection of the sternum, bifid at the end. Stigmatic hairs medium length, slightly spatulate at the ends, where they are roughened with small points; cephalothorax and tectum covered with evenly-scattered, rough, elevated spots; wings of tectum reticulated with small raised ridges; all joints of the legs, except the *tarsi*, thick, rather flattened, broadest anteriorly, and rough with sinuous ridges. No hairs on the *vertex*, two short ones at the point of the rostrum, one or two on each of the first four joints of each leg, and numerous ones on the tarsus. Dorsal plate of the abdomen a long oval, rounded posteriorly, with a waved edge prolonged anteriorly over part of the cephalothorax, and ending in a sharp point soldered to the tectum; edges of the plate slightly projecting in front, a narrow transverse ridge near the anterior point, from the ends of which ridge other ridges start, nearly at right-angles, and then curve out to the before-named projecting ridges: in the centre of the space between these ridges is a light-coloured depressed, oblong marking with rounded corners. This looks clear, and, when the dorsal plate is removed and looked at from the inside, it is seen to be due to the chitine being absent, or extremely thin, there seeming to be a membrane only. Dorsal plate thickly dotted round the edges, but with much larger elevated markings, having the appearance of rings by transmitted light, towards the centre; four small spatulate hairs at the anal margin, and two lines of four or five similar ones down the back. Whole under surface strongly spotted; anal plates large, raised, and pentagonal; vulval plates nearly square.

GENUS EREMÆUS.

22. EREMÆUS OBLONGUS. Koch.

Koch, fasc. 3, pl. 24.

Nic. 451.

Found everywhere; common.

23. EREMÆUS CYMBA. Nic.

Nic. 452.

Found at Epping Forest, and near Tamworth. Rare.

GENUS NOTHRUS.

24. NOTHRUS SPINIGER. Koch.

Koch, fasc. 2, pl. 18,

Nic. 455.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

25. NOTHRUS HORRIDUS. Herm.

Notaspis horridus. Herm. 90.*Oribata horrida.* Gervais, iii. 254.*Nothrus horridus.* Nic. 456.

Nothrus runcinatus. Koch, fasc. 29, pl. 23 } nymph in different
 „ *sinuatus* „ „ „ „ 22 } stages.
 „ *mutilus* „ „ „ „ 18 ?

Found everywhere.

It seems quite possible that Thörell's *Nothrus borealis* may turn out to be a northern variety of this species.

26. NOTHRUS BICARINATUS. Koch.

Koch, fasc. 29, pl. 16.

Nic. 456.

Nothrus furcatus. Koch, fasc. 30, pl. 3 } nymph.
 „ *segnis.* Hermann, 94 }

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and Loch Maree.

27. NOTHRUS PALUSTRIS. Koch.

Koch, fasc. 29, pl. 13.

Nic. 457.

Nothrus palliatus. Koch, fasc. 29, pl. 31 } nymph.
 „ *bistriatus* „ „ 30 „ 4 }

Nymph found by Mr. George at Kirton Lindsey and by me at Epping Forest and Loch Maree: perfect creature found at Loch Maree.

28. NOTHRUS NANUS. Nic.

Nic. 458.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

29. NOTHRUS THELEPROCTUS. Herm. Pl. X. Fig. 3.

Notaspis theleproctus. Herm. 91.*Liodes theleproctus.* Heyden.*Nothrus theleproctus.* Koch, fasc. 29, pl. 10 } carrying cast skins.„ *convexus* „ „ „ „ 1, without cast skin.„ *farinosus* „ „ „ „ 8, carrying one cast skin only.„ *canaliculatus* „ „ „ „ 7, washed clean ?

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and near Tamworth.

Koch's and Hermann's descriptions may serve without repetition, as the species is very distinct. It usually carries the cast

dorsal skins flat on the abdomen concentrically, hence the concentric horseshoe-shaped lines figured by those authors. The point at the anal end of the abdomen is formed only by a projection of thin chitine, and may break away without injury to the creature; it seems to me that Koch's *canaliculatus*, which is founded on a single specimen fished out of water, may have been *theleproctus* washed clean, and with the cast dorsal skins and anal projection gone. The description, however, is not sufficient to make sure of this.

The constriction in the cephalothorax in Hermann's figure is far too deep.

The larva of this species, which I have bred, is very light brown; cephalothorax short and broad; stigmata very open, pointing upwards, and with a serrated margin; stigmatic hairs short and spatulate; abdomen much and irregularly wrinkled, straight anteriorly, broadest in the middle, thence drawn out to a blunt point, with two spatulate hairs; anus long, and about central in the abdomen; being usually far forward; legs very short and stout, with spatulate hairs (see Plate X., Fig. 2).

The nymph is almost similar to the perfect creature, but of course with a smaller number of cast dorsal skins.

GENUS DAMÆUS.

30. DAMÆUS GENICULATUS. Linn.

Acarus geniculatus. Linn. vol. ii. 1025.

Koch, fasc. 3, pl. 13.

Nic. 460.

Damæus torvus. Koch, fasc. 3, pl. 14. Nymph.

Notaspis clavipes. Dugès.

Found everywhere; very common under bark of dead trees, in dead wood, &c.

Great confusion has existed between this species and *clavipes*.

31. DAMÆUS RIPARIUS. Nic.

Nic. 461.

I found two specimens at Loch Maree of what I think must be this species, although they are rather smaller than the size given by Nicolet, and the sinuated anterior margin to the abdomen mentioned by him is hardly, if at all, shown; in all other respects they agree. I think it better to disregard these differences, although Nicolet relies on the sinuated margin, than to call these specimens a new species; the difference may arise from locality.

32. DAMEUS CLAVIPES. Herm.

- *Acarus geniculatus*. Linn. vol. ii. 1025.
- Oribata geniculata*. Fabricius, 'Ento. Sys.' vol. iv. 431.
- " " Latreille, 'Gen. Crust. et Ins.' 149.
- " " Schrank, vol. iii. 208.
- Notaspis clavipes*. Herm. 88.
- Damæus geniculatus*. Koch, fasc. 3, pl. 13.
- Acarus corticalis*. De Geer, vol. vii. 131.
- Damæus auritus*. Nic, 463.
- " " Murray, 216.

Found at Epping Forest; not common, although Nicolet says it is in France.

I have not followed Nicolet's name, although adopted by Murray, as I fail to see why he took the name which Koch had given to the species Nicolet calls *riparius*, or why Hermann's far older name of *clavipes* should be discarded; no doubt the earlier writers did not distinguish between this species and *geniculatus*, and included both under one description, but Hermann's figure is certainly this species and Nicolet says that it is.

33. DAMEUS VERTICILLIPES. Nic.

Nic. 462.

- Damæus nodipes*. Koch, fasc. 30, pl. 6.
- " *onustus*. " " 38, " 7, with coating of dirt and cast skins.

Found at Epping Forest and Loch Maree.

Most of the specimens of this creature which I have found have been thickly covered with fine white dust, like *pulverulentus* (Koch); this is not mentioned by Nicolet.

DAMEUS NITENS. Koch.

34. *Oppia nitens*. Koch, fasc. 3, pl. 10.

Average length about .48 mm.

" breadth " .32 "

I have a specimen or two found in cellars at Mortlake, Surrey, and at Tamworth, which strongly resemble Koch's *Oppia nitens*, but it is difficult to say for certain, as his description is so slight; but rather than make a new species I adopt his.

Colour brown; cephalothorax about half the length of the abdomen, conical about two-thirds of its length (from the front) then widening sharply to a slight shoulder, which is indented for the insertion of the first pair of legs, but forms an irregular projection extending from these to the insertion of the second pair; stigmatic tubes more widely separated and less raised than usual in

genus. A long hair standing upright midway between each stigmatic tube and the central line, two further forward, and two short curved ones at the point of the rostrum. Abdomen oval, slightly pointed posteriorly, very polished, two rows of long light hairs round margin, two separate ones in the centre of the back (transversely), near the anus, and four shorter round the anal margin; coxæ of first two pairs of legs concealed from above, those of two posterior pairs conspicuous; legs with the femoral joints very short and cylindrical, other joints as in *geniculatus*; a few light hairs on each joint.

DAMÆUS SPLENDENS. Koch.

35. *Oppia splendens*. Koch, fasc. 32, pl. 6.

Average length about .31 mm.

„ breadth „ .14 „

I am not able to see any sufficient distinction between the genera *Damæus* and *Oppia*, and therefore I have not adopted the latter.

Found at Wandsworth, Epping Forest, and near Tamworth.

This is the smallest member of the *Oribatidæ* I have found; why Koch called such a minute, unobtrusive creature *splendens* I cannot explain, unless it were a kind of grim joke: his descriptions and figure, however, leave little doubt as to identification; indeed, the very small size and the singular way in which the joints of the legs are enlarged nearly into balls, making the legs under a low power look like a string of beads loosely strung, distinguish it at once. This is conspicuous and exceptional at the insertion of the tarsi in the first two pairs of legs. Stigmatic hairs rather long, with a flat, fusiform, pointed club.

GENUS TEGEOCRANUS.

36. TEGEOCRANUS LATUS. Koch. Pl. IX. Figs 1, 2, and 3.

Cepheus latus. Koch, fasc. 3, pl. 11.

Tegocranus cepheiformis. Nic. 465.

Found by Mr. George at Kirton Lindsey and by me at Epping Forest; not uncommon.

The English specimens have not the two hairs on the vertex figured by Nicolet, and they have two pairs of hairs in front of the mouth instead of one.

I have retained Koch's name, being unable to see why Nicolet has rechristened this and bestowed Koch's name on a different creature (discovered by Nicolet).

This is the species above referred to, of which I have bred the very singular larva and nymph, neither of which have, I believe,

been before observed, and seen the latter change to the perfect form.

Larva a flattened ellipse, truncated anteriorly; dorsal surface coarsely reticulated, with a round opaque central spot. From the edge of the body project ten long, clear, stout spines, each doubly curved, so as to approach the line of beauty in shape, and armed with short spikes at intervals. Two rows of four similar spines on back.

The nymph is similar in shape, but the form of the ellipse becomes broader with each change of skin; it does not lose the whole of the larval skin, but carries the dorso-abdominal portion of that and of its own cast skins, *in situ* on the back, lying flat, and concentrically. Texture same as larva, colour a trifle darker with each change of skin. From the edge of the dorsal skin proceed sixteen large trifold, or quadruple, somewhat chitinous projections, the form and arrangement of which will be best understood by reference to Plate IX. Fig. 2; the central lobe of each projection carries a spine like the larval one, inserted (in appearance) like a bird's quill; the small pointed portion of the projection which springs from the base of this spine, as shown in the figure, is absent in some specimens. The spines and projections occurring on each skin give the creature an effect of great complication. It lives on the bark of old trees, under moss, and keeps flat on the wood, thus its spines must form an efficient protection.

TEGEOCRANUS CORIACEUS. Koch. Pl. XI. Fig. 1.

37. *Carabodes coriaceus*. Koch, fasc. 3, pl. 15.

Average length about .62 mm.

„ breadth „ .4 „

Found at Epping Forest.

Opening for mouth organs almost entirely closed by *labium*; second joint of *palpus* only slightly thicker than third, fifth joint not toothed; mandibles short and strong. Whole creature very black, but dark red brown where seen by transmitted light (as in the stigmata).

Form short and broad; *cephalothorax* very broad, flat, triangular, and joined to abdomen by the full breadth of the former; median part (longitudinally) depressed and lighter in colour; central (also longitudinally) in this light space are two small raised black ridges, so close together as to appear one; these commence in the centre of the cephalothorax and extend back to near the abdomen, then cease abruptly. Sides of cephalothorax raised along the whole length, extending laterally into broad, horizontal expansions, pointed anteriorly, broadest posteriorly, where they turn inwards at acute angles, become more raised, as though turned on edge, and follow the curve of the abdomen; before reaching the

median line they expand into rounded lumps, which are the most raised, and then become narrower and turn back to meet the lateral expansions: between the two lumps and opposite the termination of the first-named ridges is a narrow depression, not quite down to the level of the cephalothorax; this communicates with a deep and wide depressed channel between cephalothorax and abdomen: from near the ends of this channel proceeds a smaller one which runs round the abdomen. There is a raised, rough, exterior margin, which is prolonged into small angular corners; within this channel the abdomen is almost circular, and much raised and marked like morocco leather, whence doubtless Koch's name. Stigmata large, raised, and pointed outward, stigmatic hairs curved forward and thickened towards the ends; two rows of about four rather spatulate white hairs on the back, and some shorter, projecting from posterior margin. First pair of legs inserted in a deep cleft of cephalothorax, which is open above and below; second pair supported by a projecting plate. All trochanters, but particularly first pair, very thin where inserted, and greatly and suddenly thickened towards the middle.

Lives chiefly in fungi growing on old trees.

38. *TEGEOCRANUS LABYRINTHICUS*. Mihi, Pl. XI. Fig. 2.

Average length about .45 mm.

„ breadth „ .25 mm.

New Species.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and near Tamworth.

A small species, of a deep red brown colour, the whole creature covered with raised dots, close together and often coalescing, arranged in winding lines leaving narrow depressions between.

Cephalothorax triangular, broad, and joined by its whole width to the abdomen. Along whole length of cephalothorax runs a broad, free, raised, reticulated expansion, about equal in width until near its anterior point, but having a semilunar depression in the margin near where it joins the abdomen. Stigmatic hairs with thin stalks and piriform, clubbed ends. First and second pairs of legs set in shallow clefts of cephalothorax; all trochanters enlarged beyond the middle. The *abdomen* has the sides almost parallel, hind margin rounded, anterior ditto truncated and only slightly curved. The border usually found round the abdomen in this genus is wanting or rudimentary, but the anterior angles are expanded adjoining the cephalothorax. A row of short, straight hairs round the hind margin.

I believe this species to be unrecorded, and propose to call it *labyrinthicus*, from the maze-like arrangement of the rows of dots on the back.

39. *TEGEOCRANUS ELONGATUS*. Mihi, Pl. X. Fig. 7.

Average length about .68 mm.

,, breadth ,, .32 ,, at broadest part of abdomen.

,, ,, .2 ,, where abdomen joins cephalothorax.

New Species.

Colour black; whole creature from point of rostrum to anus a very long piriform shape, broadest near posterior end, which is rounded, the line of the cephalothorax running continuously with the abdomen in shape, but the wings of the cephalothorax standing beyond the line.

Cephalothorax long, a third of the length of the whole creature, conical, nearly flat, sides raised into projecting wings, almost horizontal. Anterior surface of the vertex covered with slightly raised irregular ridges. Stigmata at the extreme edge and posterior limit of cephalothorax. Stigmatic hairs short, slightly curved back, gradually thickened towards the end, which is rather bilobed. Hairs of the vertex very long, almost reaching the point of the rostrum; a hair from beyond the middle of each wing-like ridge curved over the rostrum, the two crossing; two shorter hairs near point of rostrum curving downwards. Last two joints of the legs slighter than usual in the genus. Abdomen coarsely reticulated, nearly straight anteriorly, with two small, projecting, blunt points; border of abdomen narrow and with rough edge, four lines of long hairs down its dorsal surface, and a line of strongly recurved shorter ones round the edge. On the ventral surface, below the wing-like edges, is seen, on each side, a shorter similar ridge, reticulated, and armed with three curved teeth on the anterior edge. Genital plates much rounded.

This creature is exceptional amongst the *Tegeocrani* from its lengthened form, otherwise it presents all characteristics of the genus.

I believe it to be unrecorded, and propose to call it *Tegeocranus elongatus*.

It lives in dead wood and is very sluggish.

GENUS HERMANNIA.

40. *HERMANNIA PICEUS*. Koch.*Nothrus piceus*. Koch, fasc. 29, pl. 2.*Hermannia crassipes*. Nic. 469.

Murray.

(?) *Hermannia reticulata*. Thörell, loc. cit. Nymph.

Found everywhere. Common.

Thörell's description of his *reticulata*, found at Bell Sound, appears to correspond with the adult nymph of this species.

41. HERMANNIA ARRECTA. Nic.

Nic. 470.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest. Not uncommon.

GENUS HOPLOPHORA.

42. HOPLOPHORA MAGNA. Nic.

Nic. 472.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and Loch Maree. Not uncommon in dead wood.

43. HOPLOPHORA STRICULA. Koch.

Koch, fasc. 2, pl. 10.

Nic. 472.

Found at Kirton Lindsey by Mr. George, and by me at Epping Forest.

44. HOPLOPHORA DASYPUS. Dugès.

Oribata dasypus. Dugès, 'Mémoire sur l'ordre des Acariens,' 47.

Hoplophora contractilis. Clap., 'Studien an Acariden.'

Murray, 222.

Phthiracarus contractilis. Perty.

Hoplophora nitens. Langle (unpublished).

" " Nic. 423.

Common everywhere in dead wood.

I do not see why Dugès' name, which seems to be the earliest, has been abandoned; I have therefore used it.

XIII.—Notes on the Pygidia and Cerci of Insects.

By HENRY DAVIS, F.R.M.S.

(Read 13th November, 1878.)

SOME years ago most microscopists quoted the pygidium of a flea as being one of the best of definition tests, and although doubtless it is now well known as being so variable, that for comparative trials (where objectives are not tested on the same specimen) it is practically of little value; still its delicate beauty, the puzzle as to its function, and the fact of its being generally considered as an organ unique amongst insects, keep it to the present day as an object of abiding interest, and one without which no cabinet would be called complete.

As one of its early admirers, I gave it, some years ago, considerable attention, and was able not only to convince myself that the angular, square-shouldered outline of the rays in the areola, thus figured in the 'Micrographic Dictionary,' has no foundation in fact, but that those areolæ possess some outer structure which seems hitherto to have escaped notice. It has afforded me a somewhat malicious pleasure in challenging those of my friends who used high modern powers, to discover this structure for themselves. They invariably failed. A small-angled $\frac{1}{4}$ -inch objective, fully twenty years old, first showed that, looking on an areola as representing a carriage wheel, a line proceeds outwards from the tire between each spoke, and these lines being bounded by a circle, give resemblance to a wheel within a wheel: the new wheel or circular band is, when the object is unflattened by pressure, at right angles to the plane of the inner wheel; the first forming the sides, and the latter the bottom of a little pit, from the centre of which springs the well-known fine long hair.

This is not brought forward for the purpose of glorifying old objectives, or decrying the power, optical and manipulatory, of certain microscopists, but rather to show the advantage of mounting one's own preparations; for the structure can only be well made out when the object is placed in a position which a professional mounter would endeavour to avoid and consider as wrong side out.

Until 1870, when Mr. Peake discovered a pair of pygidia on the Lace-wing fly (*Chrysopa peola*), the Flea appears to have been the only insect known to possess this appendage, and, after diligent inquiry, I cannot find that since that date any published addition has been made to the number. But in December, 1870, it was my fortune to notice two pygidia on a fine Locust (*Locusta migratoria*) I had captured near Cadiz, and after finding these the road was made to very many discoveries in other, mostly allied, insects. It

will be a safe, because an under, statement to say, that without any special search, fifty insects of different species are now proved to possess pygidia. The organ is here spoken of in the plural, as with the single exception furnished by *Pulex*, all the insects examined have it in pairs more or less separated; even in the Flea it is distinctly double and bilateral, and I submit it should no longer receive the singular appellation except when divided.

It would doubtless be satisfactory to give a full list of all the insects on which I have found pygidia, but it happens that by far the greater number are exotic, taken, some at the Cape of Good Hope, some in Mauritius, and other places abroad; the correct naming is a difficult task; even Mr. Frederick Smith of the British Museum shrank from it, and I am constrained to speak of the foreign species in general terms, but will give particular examples in common English insects.

The pygidia of the Lace-wing may be taken first, as introductory to a series gradually increasing in size; they are found as nearly circular, flat, or slightly convex plates, one on each side of the last (posterior) joint of the abdomen; they are dorsal, and only require to be pushed (so to speak) closer together to be exact copies of the pygidia of the Flea. It has a similar collection of the same shaped areolæ and the same characteristic fine long central hair. Next to this, as having pygidia of the nearest resemblance to that of the Lace-wing, comes the common small Grasshopper (*Gryllus*); in this the organs project slightly, conical in figure and somewhat flattened at the sides, but otherwise they are exactly similar to the only pygidia hitherto known. In the large Grasshopper (*Acrida viridissima*) the parts are much longer and not easily overlooked, while in the Cricket (*Acheta domestica*) we find these same organs extended to an immense length—sometimes three-quarters of an inch—but still bearing the peculiar structure of rayed and haired areolæ. The Mole Cricket (*Gryllotalpa vulgaris*) also has large and beautifully marked pygidia.

In the Cock-roach (*Blatta orientalis*) may be found corresponding large appendages, which are called *cerci* by Burmeister; except in position, there is little at a glance to identify them with the parts we have seen. They are nearly bare on the superior surface, and the under side, often turned upwards and outwards, only is furnished with any long hairs; nor are these set in broad, deep sockets like those described, but are attached to small, clear, unrayed spaces, flush with the chitinous integument. To found a belief that these cerci are really pygidia, it requires considerable acquaintance with the latter's various modifications, and, above all, a knowledge of the very peculiar properties of the long hairs to be mentioned presently.

Of foreign insects having pygidia, I purpose saying little,

although they have supplied the greatest number and variety of examples. Among these it really would seem as if all the orthopterous insects have them, and most of the Neuroptera. Some are very minute, even when the owner is of large size; others greatly elongated, as in *Lucina opilioides*, where the organ is over an inch long. Curious instances may be found in *Thuraxalis*, in *Heterodes*; also in an Indian Grasshopper (possibly anonymous), which has the organ twisted, and tipped with a hard serrated hook.

As regards the function of pygidia, it might appear, at first sight, that the new examples being mostly of large size, there would be little difficulty in investigating and determining a matter which, in the case of *Pulex*, has vainly taxed the skill, patience, and acumen of many excellent observers; and probably if the subject were taken up again by biologists well versed in the anatomy and physiology of insects, satisfactory results might accrue; but as a matter of fact, the inquiry is by no means an easy one, and after considerable study of fine and various specimens, I, for a long time, only arrived at a conclusion—an old one, it would seem, of the late Mr. Richard Beck—that pygidia are collections of tactile hairs forming posterior feelers; but quite lately, almost by an accident, I was enabled to see that, while they may be this, they certainly are something, and very much, more.

I had a pygidium of a Cricket under a low power, and was surprised to see a strong, waving motion in the hairs; this, at first, was attributed to action imparted at the will of the insect, although it was at the time stupefied and quieted with chloroform; but the same sort of movement occurred when the creature was quite dead, and when only a thin section of the organ was under the Microscope. It was found that the hairs are so light and so delicately attached, that the ordinary breathing of the observer, at fully ten inches distance, set them in motion; and a slight movement of the hand a foot or more away caused a visible disturbance, which is not a mere vibration, but a rocking of the motile hair in its socket, and of the disk by which it is attached. In repeating this experiment, it is necessary to examine the part within a short time of the death of the insect, and before the *rigor mortis* has set in; otherwise the little disk at the base of the hair (sometimes there is a rounded end, but never a root) will become more or less firmly fastened to the white (nervous?) matter in which it seems set, and the hair will be found comparatively insensitive.

It will be seen that as mere tactile hairs they are far too delicate; moreover, examples may be found in some species of Lace-wing, and notably in the Flea of the Pigeon, where by being surrounded by coarse true hairs, or placed under stout curved spines, they are partly or wholly protected from contact with external bodies. I am led to believe pygidia to be collections of

motile hairs, forming organs of feeling induced by the movement of the air in their neighbourhood; not, perhaps, an organ of a new sense between touch and hearing, but of feeling not excited in the ordinary way by actual touch. I apprehend that any insect having pygidia must infallibly be warned of the approach, however stealthy, of an enemy; even if, from its position behind the insect, that enemy could not be seen, the warning being given by the moving hairs actuated by the disturbance of the surrounding air.

In these notes I think may be found reasons for discarding the use of the word "cerci," as applied to all those insect organs which are plainly modified forms of the better known "pygidia." The latter simply meaning something on the *uropigium*, will permit them to be of any form or size; and as "cerci" means tails, it is absurd to apply it to objects of no length, as the pygidia of *Chrysopa* and *Pulex*. But if these be tails, then indeed man himself has one.

XIV.—*On Stephenson's System of Homogeneous Immersion for Microscope Objectives.**

By Professor E. ABBE, of Jena, Hon.F.R.M.S.

(*Read 12th March, 1879.*)

THE inventor of the Immersion method, Amici, with whose name so many important improvements in the Microscope are connected, attempted to use other fluids than water for the immersion medium. Amongst others he tried the highly refractive oil of aniseed, probably from the idea that the advantage obtained by replacing the stratum of air by a more refractive medium would increase with the increase in the refractive indices of the media employed. More recently others have used glycerine, and the well-known American optician Spencer has, according to report, produced objectives by this means of excellent quality.

The theoretical analysis of the immersion principle shows, that in several respects far more favourable results can be attained with a highly refracting substance than with water: it proves, however, at the same time, that the advantage to be expected is by no means proportional with the progressive increase in the refractive index; on the contrary, there is a maximum beyond which the results become less favourable. When the cover-glass and the front lens are of crown-glass, which is generally the case, this maximum is reached when the immersion fluid has the same refractive index as crown glass. A connection, which is optically homogeneous, is then established between the preparation and the objective, which eliminates all refraction in front of the first spherical surface of the optical system. Not only is the loss of light by reflection obviated, a loss which is experienced at every surface separating different optical media when the incident rays are oblique, but what is still more important, a very considerable amount of spherical aberration is at the same time prevented which otherwise would have to be corrected in the upper portion of the objective, but which must leave a residuum. Apart therefore from other advantages, such a method of "homogeneous immersion" gives promise at all events of a more perfect elimination of spherical aberration, and consequently more favourable conditions for what is called "definition" of the objective, than water immersion. It also possesses the further advantage, which is by no means inconsiderable, of getting rid of the disturbing influence of the cover-glass and doing away entirely with the otherwise indispensable correction. For where the intervening medium is equal in its refraction and dispersion to the cover-glass, it is immaterial, as regards the optical effect, whether a

* Translated by R. Woodall, Esq., F.R.M.S.

thicker layer of glass and a corresponding thinner layer of the fluid, or *vice versa*, is inserted between the object and the objective.

The idea of realizing the various advantages of such a kind of immersion, by constructing objectives on this system, had for some time presented itself to my mind, but I thought that there was not much to be expected, as regards the scientific usefulness of such objectives, as I believed their use would be limited on account of the necessity of using oil or some other inconvenient material as the immersion fluid. It appeared to me that, except perhaps for the examination of diatoms, scarcely any other scientific sphere remained than petrographic research, which would afford scope for realizing the optical advantages of such objectives.

The matter assumed, however, subsequently a different shape in consequence of a suggestion made by Mr. John Ware Stephenson (the Treasurer of the Royal Microscopical Society of London), who independently discovered the principle of Homogeneous Immersion,* but by whom, in addition to its other advantages, special attention was drawn to the doing away with the cover-glass correction, and to the possible enlargement of the angular aperture, with consequent increase in the resolving power of the objective. This idea of Mr. Stephenson, which made the matter one of universal scientific interest, was at once followed out, the calculations being made by me, and the technical execution by Mr. Zeiss, and resulted in the production of a series of objectives on this system which in several respects are manifestly superior to the ordinary water-immersion objectives. Having now been used by a number of microscopists, it has been found, that although the nature of the peculiar immersion fluid will naturally much restrict the employment of such objectives, it does not present any obstacle to their use in various widely different spheres of microscopic research; and in particular, biology furnishes many problems to which the new lenses may render useful service.

Since the construction, about a year ago, of the first objectives on this system, the focus being $\frac{1}{8}$ " nominal (more exactly 2.6 mm. equivalent focus), and all of them calculated for the long tubes of the English Microscopes, some have been made of $\frac{1}{1\frac{1}{2}}$ " (1.8 mm.), which give sufficient magnifying power, even with the shorter tubes of the continental instruments; and quite recently a third series, $\frac{1}{1\frac{1}{8}}$ " nominal (1.2 mm. focus) has been produced, by which, especially in histological observations, great amplification can be obtained with low eye-pieces.

The angular aperture of all these objectives is about 114° in the immersion fluid for which they are adapted, the index of refraction being taken in round numbers as $= 1.50$.

* J. W. Stephenson "On a Large-angled Immersion Objective without Adjustment Collar," &c.—This journal, i. (1878) 51.

This is approximately the same *angular* magnitude as can be attained without any great difficulty within the film of water in the usual immersion lenses, or within the stratum of air in dry objectives. But since the "numerical" equivalent of the angle of aperture (the measure which determines the number of rays taken in by the objective) is proportional not only to the sine of half the angle of aperture, but also to the refractive indices of the respective media employed, and since all the functions of the angle of aperture, and especially the resolving power of the Microscope, are regulated by this numerical equivalent, it follows that, according to theory, the capacity of the new objective, compared with that of ordinary immersion lenses, is increased in the proportion of 1.50 to 1.33, and as compared with the highest dry objectives, as 1.50 to 1.

The product of the sine of half the angle of aperture into the refractive index of the medium—the "numerical aperture," as I call it—reaches 1.25 to 1.27 in these objectives. The ratio of these figures to unity expresses how much greater is the number of rays admitted by the new objectives, over that number which *in air* would fill a complete hemisphere, or which would be admitted by an imaginary dry objective of 180° aperture.

This unusually large aperture is accompanied with a notable increase of resolving power. This is at once evident by the facility with which very fine striæ and similar markings become visible on the more difficult test objects; by the plainness with which the characteristic markings stand out on the more complicated forms, such as *Frustulia saxonica*, *Surirella gemma*, &c.; and lastly, by several unusual features which appear when certain methods of illumination are employed on the coarser tests of this kind, e. g. *P. angulatum*.

Histological preparations also furnish instances of very small elements closely clustered together, granulations and such like, in which clearer and more definite resolution is obtained in critical cases.

At the same time, in all these objects, especially in those last named, the decidedly more perfect definition which homogeneous immersion renders possible, is obtained, provided that the precision of the technical execution is adequate to the reduction effected in the residual aberration as indicated in theory. Therefore, when comparatively strong eye-pieces are used the image retains great sharpness, so that in regular work higher amplification can be usefully employed than is usually the case with other objectives of equal focal length. They also often enable more exact observations to be made of very delicate objects, such as fine cilia, than good immersion objectives of the ordinary kind would permit.

Lastly, as a proof of excellence of definition which, though indirect, is of special weight, may be mentioned the favourable

results which Dr. Koch, of Wollstein, obtained when examining bacteria,* viz. by employing a full cone of rays filling the entire aperture of the objective, a method of illumination quite unheard of as applied to such objects and with such an angular aperture. With this illumination, which can only be effected by the aid of a condenser of large aperture, the preparation is simultaneously penetrated in all directions by the incident rays. As a result, the delineation of such parts as stand out in mutual contrast through difference in refractive power (tissue structures, &c.), is almost completely suppressed, and there remain visible only those elements which act as absorbents through staining. On the other hand, the essential advantages of oblique illumination are retained, although the illumination remains central in name, in consequence of the co-operation of the rays incident at a large angle towards the axis of the Microscope. Very small and closely clustered elements, as in preparations of bacteria, must certainly on both these accounts become capable of a more thorough resolution than with central illumination of the usual kind; if, however, this ingenious method of observation is to show corresponding results, the defining properties of the objective must stand a most severe test, and this test will be the more severe in proportion to the magnitude of the angular aperture employed.

As regards the nature of the immersion fluid, it is of course on optical grounds a matter of indifference what is selected, so long only as it is homogeneous and transparent, and equal, or very nearly equal, to crown glass in refraction and dispersion. Experiment has taught, however, that this condition of homogeneous immersion leaves a much smaller choice than might be anticipated. At the outset I examined over one hundred fluids of the most varied kinds—essential and fatty oils and artificial chemical preparations—which I either tested myself or caused to be examined with the refractometer, to determine their refractive and dispersive indices, and lately the investigation has been carried still further by Dr. Töpel, who, under my guidance, determined the optical constants of nearly two hundred chemical combinations from the collection in the laboratory of the Jena University, which Professor Geuther was kind enough to place at our disposal. Among all these, however, not one was found which from its other properties could be used; which either alone or mixed with other fluids attained the refractive index of crown glass (1.515 to 1.520 for sodium light) without at the same time more or less exceeding the dispersion of crown glass. A few only of the substances examined satisfied the necessary conditions with sufficient accuracy to permit the deviation to be regarded as unimportant.

The most suitable fluid that has at present been discovered, is

* ‘*Aetiologie der Wundinfektions-Krankheiten.*’ Leipzig, 1879.

cedar-wood oil (prepared by Schimmel and Co., Leipsic and New York) an essential oil almost without colour or smell, and not volatile, but unfortunately rather thin. Its refractive index at a medium temperature is about 1.51, whilst the dispersion only slightly exceeds that of crown glass. The objectives have therefore been constructed for use with this oil.

For a more extended application of the principle of homogeneous immersion great advantage is derived from the fact, that by mixing one of the more highly refracting essential oils, such as oil of cloves, fennel, aniseed, or others, with a certain quantity of olive oil, fluids can be readily obtained which are equal to cedar-wood oil in refractive power, but whose dispersive power may be increased more or less, as required. This provides a means of regulating the chromatic correction of greater delicacy than is attainable by any mere mechanical correction, inasmuch as for cedar-wood oil can be substituted mixtures of various dispersive power, according to the nature of the object to be examined and the kind of illumination required. By this simple means, for example, the chromatic difference of spherical aberration, a correction-defect which (in the present state of practical optics) it is impossible to overcome in objectives of large aperture, is rendered for the most part immaterial. This unavoidable defect is apparent from the fact that the central and peripheral zones of the objective are never simultaneously perfectly achromatic. An objective which with oblique light gives an image as free from colour as possible, is found, when central illumination is used, to be chromatically under-corrected to a marked degree, in the case of a sensitive object, and conversely. This is the more striking the larger the angular aperture. If, now, instead of a stratum (with parallel surfaces) placed in the course of the rays we substitute another of equal refractive but different dispersive power, we obtain a simple means of changing the chromatic correction of the objective without altering the spherical correction, and if, as is done throughout in the construction of these lenses, the chromatic compensation is so arranged that the fluid having the lowest dispersion (cedar-wood oil) produces the best achromatism for oblique light, the use of a more highly dispersive mixture of the kind mentioned will correct the chromatic defect for central illumination which would otherwise appear.

The application of this method is adversely affected by one circumstance only, viz., that the effect of a determinate increase in the dispersion naturally depends upon the thickness of the fluid stratum. With covering glasses of different thickness, as also with objectives of different focal lengths and corresponding different working distances, one and the same mixture will yield more or less unequal results.

Since the exact adjustment of the immersion fluid thus appears

essentially necessary if the capacity of the new objectives is to be fully utilized, it is important to have a simple means of regulating the refractive and dispersive powers of the fluids in their relation to the corresponding factors in crown glass without having to employ special measuring apparatus. For this purpose Mr. Zeiss furnishes with each objective a small glass bottle with parallel sides, to the glass stopper of which is cemented a crown glass equilateral prism. This test bottle may be used in preparing the combined fluids, and by viewing the vertical bar of a window frame, &c., through both fluid and prism the difference between the fluid and crown glass, both with respect to refraction and dispersion, may be at once seen. The deflection of the image of the vertical bar in passing through the prism, and the width of the coloured border, gives both these elements at a glance and with an exactness which is quite sufficient.

In the practical use of the new objective there are two further points to be specially noticed. The first is its dependence upon the length of the tube. The abolition of the cover-glass correction in these objectives, which is acknowledged by all observers to be an extraordinary advantage in manipulating the lenses with ease and certainty, nevertheless deprives the observer of a convenient means of compensating within certain limits the influence of different tube-lengths upon the aberrations.*

The objectives can therefore only be used with the length of tube for which they are originally adjusted, and they are so sensitive on this point (especially the lowest power) in consequence of the large angular aperture, that a deviation of a very few centimetres in the length of the tube produces visible changes in the condition of the correction. A draw tube to the Microscope affords therefore a very simple means of regulating according to the observer's own judgment, the ultimate more delicate adjustment of the correction, and also enables him—until some better immersion fluid is found—to compensate any small defect in the refraction of cedar-wood oil, which may be noticeable when very thick or very thin cover-glasses are used. (As lengthening the tube produces spherical over-correction, and shortening under-correction, it follows that the former corrects a very thin covering glass, and the latter one of more than ordinary thickness.)

* Dispensing with the correction-adjustment in the manufacture of such objectives is a matter of small moment in itself when compared with the other technical requirements which are met by it. An essential benefit arises, however, from the simplification of the mechanical construction, in so far as it would scarcely be possible in a combination of lenses with *movable* parts to get the lenses centered as perfectly and durably as is possible in the case of a fixed combination: and in the present instance this appears an indispensable condition on account of the sensitiveness of the large aperture to the slightest defect in centering. Looking at this circumstance, it would be most unadvisable to provide such objectives with correction collars.

In using the objectives for photography, where the image must be at a considerable distance, unless an ordinary low eye-piece is used to photograph with, an auxiliary lens becomes requisite, which will remove the image to the required distance, without altering the course of the rays in the objective itself. For this purpose a concave lens of suitable focal length may be inserted close behind the objective in the same way as a short-sighted person uses concave spectacles to move the plane of distinct vision to a greater distance; a concave lens of relatively corresponding shorter focal length may also be interposed at a greater distance from the objective, in order to produce a moderate amplification (two or three times) of the image, and at the same time a decrease in the requisite distance of the plate. The position of the auxiliary lens in this case must of course be so regulated, by computation, that the cones of rays emerging from the objective converge towards the same plane as in ordinary observation.

A second point which must not be lost sight of in using these objectives—and in fact any objective the numerical aperture of which considerably exceeds the value 1—relates to the conditions which the illuminating apparatus must satisfy, in order that the whole angular aperture may be utilized with oblique illumination.

With a numerical aperture of 1.25 an incident ray, if it is to reach the external zone of the objective, must, when it impinges on the object, be incident towards the axis of the Microscope at an angle of about 56° . Rays with this inclination cannot of course be transmitted to the objective out of air through a flat surface perpendicular to the axis, such as the lower surface of the glass slide. An incident ray reaching this surface from below would not, after entering the glass, be inclined towards the axis more than about 42° ; and with the ordinary illuminating mirror even this obliquity could never be attained, apart from the great loss of light by reflection, which would greatly detract from the effect. In order therefore to utilize the maximum degree of oblique illumination, which an objective of such large aperture will admit—of course with objects which do not lie in air—and to bring out the full defining power of the objective, an illuminating apparatus is necessary, which not only gives a cone of rays of equal aperture with the objective, but which at the same time admits of a fluid connection with the under side of the slide. One immersion condenser amongst others which fulfils these conditions, is the illuminating apparatus described by me* some years ago, the system of lenses in which (corresponding with the angle of aperture of the older immersion objectives of Zeiss) possesses a “numerical aperture” of over 1.1 for its upper focus, and in the construction of which the

* Max Schultze's ‘Archiv f. Mikr. Anat.’ ix. 496.

connection of the front lens with the under surface of the slide by a drop of water, is taken into account.* In the absence however of an illuminating apparatus such as this, and where only very oblique illumination is required, a much more simple arrangement will be found very serviceable, which consists in connecting, by means of a drop of glycerine or oil, a plano-convex lens, nearly hemispherical, of 6-9 mm. radius, to the under surface of the slide, to which it will adhere. It may be kept sufficiently centered by means of a loose brass ring attached to it, having an external diameter equal to that of the stage aperture. The ordinary concave mirror, turned slightly outside the axis of the Microscope, will then give cones of rays of any degree of obliquity which may be desired.

In conclusion, some account may be given of the optical combinations of the objectives for homogeneous immersion. Those constructed in Mr. Zeiss' manufactory, and based upon my computations, are all systems with four members. In this I have gone back to a type of construction which was applied by me experimentally many years ago, and has lately been used with considerable success by several opticians, especially Mr. Tolles and Mr. Spencer. Two single crown-glass lenses close together are made use of (duplex front) as the lower members of the system, and the two others only are compound, so-called achromatic (in the present case binary) lenses.

This form has certainly the disadvantage of leaving rather more chromatic difference of the magnifying power (that is, with perfect achromatism in the middle of the field of view there is more colour towards the periphery) than is usually found when the front lens of the system is followed immediately by a compound lens of flint and crown glass; but this defect is practically inconsiderable in comparison with the facility with which it enables the angle of aperture to be increased. The form in which I have devised this type is nevertheless essentially different from the construction of which Mr. Tolles has published the elements in detail.† The difference becomes very apparent when the radii of the front lenses are compared with the equivalent focal distances of the respective objectives. The $\frac{1}{6}$ " objective of Tolles, described in the journal referred to, has almost exactly 4 mm. focal length, and its front lens a radius of 0.73 mm. In Zeiss's $\frac{1}{12}$ ", with 1.8 mm. of focal length—consequently less than half—the radius of the front lens is no less than

* In consequence of the greater aperture of the objectives for homogeneous immersion, I have recently had a system of lenses constructed for an illuminating apparatus, the angular aperture of which reaches approximately the numerical equivalent 1.4. This will consequently give rays which are inclined 72° towards the axis in glass.

† This Journal, i. (1878) 143

0.9 mm., and even with the $\frac{1}{18}$ " (1.2 mm. focal length) the smallest radius (0.6 mm.) is very little less than that of Tolles's $\frac{1}{8}$ ", whilst an objective of equal power would require, according to Tolles's formula, the abnormally small radius of 0.22 mm.

For the advantageous application of the duplex front in obtaining larger angular aperture, the more favourable ratio between the radius of the front lens and the focal length which is here attained will be of some importance, because it provides the only possible means of producing objectives of great magnifying power, without having too much recourse to the tube and eye-piece for amplification. By Tolles's construction it would be practically impossible to make an objective such as Zeiss's $\frac{1}{12}$ ", not to mention the $\frac{1}{18}$ ", with an angle of aperture of any considerable extent, to say nothing of the intolerable limitation of the working distance of lenses so abnormally small.

As far as the mere observation of diatoms and similar test-objects is concerned, an objective of 4 mm., if thoroughly well made and possessing a good large angle of aperture, would indeed leave scarcely anything to be desired, especially as the small front lens of Tolles's construction involves relatively favourable conditions for the employment of deep eye-pieces. But when we take into consideration the much more complicated structures of the difficult objects of biological research, it cannot be doubted that systems which give considerably higher *objective* amplification will remain a real necessity until in practical optics more perfect methods of getting rid of the aberration than at present known are discovered. In my opinion, therefore, looking to general scientific requirements, the end to be kept in view at present is the production of objectives of sufficiently *short* focal length, which do not present too much difficulty in ordinary use, and this has been the principle which has guided me in my labours in this particular case.

A decidedly unfavourable feature in the formula which I have produced is the technical difficulty of construction, in which requirements are made such as were scarcely ever demanded and satisfied in the manufacture of Microscopes. In this construction the spherical surface of the front lens must be utilized to an extreme extent, and must bear angles of incidence which for the marginal rays (on the air side) exceed 45°. The manufacturing optician has therefore to produce spherical surfaces of the small dimensions of the front lens, which shall be strictly true in form to the extent of a full hemisphere, and afterwards to mount these lenses in such a manner that without affecting the firmness of their setting they shall freely admit rays of light nearly up to the equator. The difficulty of this work and the extreme sensitiveness to the least defect of form and centering of the lenses, in a system of so great an angular aperture, make the production of such objectives an

exceptionally troublesome and delicate task. All these difficulties of technical execution would, however, be considerably diminished if the increase in the angular aperture were to some extent sacrificed and we were content with a numerical aperture of $1\cdot$ to $1\cdot1$, which has hitherto been the ordinary aperture of immersion lenses.

I must for the present leave undecided the question whether the Stephenson immersion system might not prove of great practical service even under such restrictions. Of course such advantages would be surrendered as arise from the augmented resolving power, since this is essentially determined by the magnitude of the aperture. But there are surely objects enough in the domain of the microscopist, with respect to which a specially high resolving power is of less moment than the greatest possible perfection of definition; and the superiority of the homogeneous immersion system on this point, and the great advantage which the elimination of the disturbing effect of the cover-glass involves, would be diminished only to a very limited extent with a reduced angle of aperture. Assuming, therefore, that the nature of the immersion fluid admits the frequent use of such lenses, especially in biological researches, it might be desirable to try the system of homogeneous immersion in objectives of more simple construction, which would by their smaller cost be more generally used.

In the other direction, however, the extent to which the new immersion method will lead us has been by no means exhausted by the new objectives. From the result of the first step it cannot be doubted but that by this system considerably larger apertures of moderately short focal length are still attainable, notwithstanding the increasing difficulties of computation and construction. It being unquestionably a matter of interest to extend the resolving power of the instrument to its extreme limits by any means in our power, even if the unavoidable refinements in such objectives scarcely admit of their frequent application, the attempt has been undertaken in the optical manufactory here. I hope soon to be able to show objectives of 4-3 millimetres focal length, the numerical aperture of which is increased to $1\cdot35$, corresponding to an aperture angle of 128° in a medium with an index of $1\cdot50$. This figure, however, would be the extreme limit which can at present be attained, unless cover-glasses of flint glass are used for the object, and at the same time an immersion fluid of corresponding refractive index is applied.

XV.—*The Vertical Illuminator and Homogeneous Immersion Objectives.* By J. W. STEPHENSON, F.R.A.S., Treas. R.M.S.

(Read 9th April, 1879.)

THE Fellows will have seen in the April number of the Journal (p. 194) a note extracted from the 'American Naturalist' for February, in which are described the advantages found by Mr. Morehouse, of New York, to be obtained from the use of the Vertical Illuminator* in the resolution of Diatoms and Podura scales.

On reading the note, I tried the apparatus on both classes of objects, and can fully endorse the statement made as to the surprising results obtained. Slides of *A. pellucida* which were deemed worthless because all the striæ had, as was supposed, been destroyed in cleaning, were resolved with the greatest ease, and Podura showed parallel light or white lines from one end of the scale to the other, somewhat reminding one of *Lepisma*. The Vertical Illuminator was soon after its first invention discarded by practical microscopists on account of the amount of fog which was caused by the reflection, at the upper surface of the cover-glass, of the rays transmitted through the objective. It is obvious that *this* fog will not be observed when an oil-immersion objective is used, as in that case the front lens of the objective, the intervening stratum of oil, and the cover-glass itself, are all optically continuous, so that the upper surface of the cover-glass has optically ceased to exist, the only reflection being from its under surface when dry objects are used. An additional advantage is therefore found for homogeneous-immersion objectives.

My object is not, however, to deal with this branch of the subject, but with an entirely different application of the Illuminator, not noticed by Mr. Morehouse, but which appears to me to be of great scientific interest.

This point is the *visible* demonstration which the Vertical Illuminator affords, not only that many modern objectives, and notably those on the homogeneous-immersion system, have angles far exceeding the equivalent angle of 180° , but also that the extent to which this excess is in any particular case carried, can at once be appreciated.

The existence of this excess, although at one time doubted, has

* As several inquiries have been made as to what instrument is meant by the "Vertical Illuminator," I may refer to Dr. Carpenter 'On the Microscope,' 5th ed., p. 153, where the instrument is both described and figured. A small silver speculum (Professor Smith), or a movable disk of thin glass (Messrs. Beck), or a piece of parallel glass fixed at an angle of 45° (Messrs. Powell and Lealand), is fixed in a short tube (with a side aperture) interposed between the objective and the body of the Microscope, by which means a pencil of light entering at the aperture and striking against the speculum or inclined surface of the disk or plate, is reflected downwards through the objective upon the object.

since been abundantly proved, and the present method affords an ocular demonstration of the fact, most conclusive in its character and fully supported by theory.

It will be seen, on removing the eye-piece of the Microscope, after having reflected a full beam of light through the objective, by means of the Illuminator, and after having focussed the instrument on any dry object adhering to the cover, that within the margin of the lens there exists a brilliant annulus of light, and that the circumscribed internal space appears by comparison to be quite dark.

This annulus represents, and is produced by, the excess of aperture beyond the equivalent angle of 180° , or what is called the "*plus* 180° ," of which it is also the measure.

The internal dark space is of the exact diameter of that of a dry objective of the same focus, and is in fact the maximum space which it can itself utilize, on a dry object, by transmitted light.

On looking down the tube of the Microscope on which is one of Zeiss's homogeneous-immersion $\frac{1}{4}$ ths, with its numerical aperture of 1.25, it will be seen that the annulus has an apparent magnitude corresponding with that attributed to it by theory, that is to say, a width equal to one-fourth part of the radius of the dark central space.

The explanation is, as it appears to me, simple enough: the beam of light reflected by the parallel glass plate of the Illuminator, is condensed by the objective, and brought to a focus on the under side of the thin glass cover, the oil (or other homogeneous fluid) having, thus far, allowed the light to be freely transmitted; but, at the focal point, having to pass from a denser to a rarer medium, the passage of all rays which exceed the critical angle (in this case 41°) is arrested, whilst those within that limit, or at all events the greater part of them, pass through the glass and are lost.

The bright image of the flame of the lamp, which is seen crossing the field of view, is therefore almost exclusively formed by the "*plus*" rays, which, being totally reflected as soon as they impinge on the air surface of the cover-glass, are sent back by the peripheral portion of the objective to the eye; it is thus evident that, unless the objective possessed the excess of aperture which we have been considering, the image could not be formed by the totally reflected rays, nor, if formed, could the reflected rays be taken up by the objective and transmitted to the eye.

These reflected rays, when seen without the eye-piece, form the bright annulus of light, and constitute, as has been shown, the aperture in excess of the 180° limit, which limit is itself as clearly indicated by the dark central area.

That this is not a mere theoretical or nominal increase is evident when we consider the areas of the transmitting portions of the lens, which are proportional to the squares of their numerical apertures or as 1 to 1.5625, so that the Vertical Illuminator picks

up the 0.5625 as against unity, which is the *ideal* maximum of the dry lens.

It is truly stated in the 'American Naturalist' that the Vertical Illuminator "can only be successfully used in conjunction with an objective of high balsam angle," and I hope the reason of this has been rendered clear.

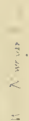
In examining a dry object with reflected and transmitted light, the optical phenomena are reversed: with reflected light we have the bright annulus and dark centre; but, with light transmitted from below, we have the central portion of the lens traversed by the illuminating pencil, which is, however, unable to penetrate the dark circle by which it is surrounded.

On objects mounted in balsam (or fluid) the Vertical Illuminator fails, as far as resolution is concerned, and it is on these that the various sub-stage immersion illuminators come into play, their greater or less success depending exclusively on their ability to induce the dioptric beam to penetrate the magic circle beyond the limit of 180° , as unless the light can be seen to touch the margin of the lens, its full power has not been developed; hence it appears that "vertical" illumination, in some form, is the only means by which the whole of the resolving power of large-angled objectives can be utilized on dry slides, just as on balsam objects immersion illuminators are indispensable.

In the foregoing observations I have throughout spoken of the bright *ring* of light, and this may lead to the impression that the whole of this ring is used, but this is not so; in practice only a small portion is employed, the greater part being shut off by a suitable *external* diaphragm or stop, just as with immersion illuminators in the sub-stage a part only of the marginal rays are employed.

This seems to suggest the substitution of a small totally reflecting prism for the parallel plate of glass, which, projecting slightly over the margin of the lens, gives a much more brilliant beam of light, but it has the disadvantage of, to a certain extent, interfering with the diffraction spectra, and thus under some circumstances, so diminishing the aperture of the glass, as to interfere with its resolving power.

The Vertical Illuminator was originally intended to be used more as a Lieberkuhn for opaque illumination with medium powers, its present use not having been foreseen. That it can be so used with even greater effect on balsamed objects now, when homogeneous immersion objectives are used, is obvious, because the light passes as direct as it formerly did on to uncovered objects in air, both the upper and under surfaces of the thin glass cover having been optically abolished—but the number of balsam objects suitable for opaque illumination with powers as high as an $\frac{1}{3}$, is very limited.



Diagrams exhibiting the part of a ray through Tolles's Immersion Objective.

XVI.—*Note on Diagrams (Plate XII.) exhibiting the Path of a Ray through Tolles' $\frac{1}{8}$ Immersion Objective.*

By Professor R. KEITH.

(Read 9th April, 1879.)

I HAVE sent with this note additional diagrams (Plate XII.) to aid in localizing the symbols and following out the formulæ used in the computation of the $\frac{1}{8}$ immersion objective made by Mr. R. B. Tolles and owned by Mr. Crisp.* The lines are not drawn to any scale, although the elements of the objective are entered upon the lines corresponding to those in the objective itself.

It will be observed that the ray of light finally emerges from the plane surface of the small lens without refraction. It is, of course, supposed to enter material of the same refractive power as the lens itself: meeting the point in discussion upheld by Mr. Wenham, viz. that there is some interior impossibility of using more than 82° of aperture in *balsam*. It will be further observed that the ray meets the plane surface at an angle of over 55° , and therefore if that surface divides the glass from *air*, it cannot pass out of the lens; since at 41° and upwards the effect of the great difference of density between glass and air is to stop the light. It is thus seen that the limit of aperture in air does not indicate the limit of aperture in any denser material, the limiting angle being greater the denser the material; being 90° when the densities are equal.

* See vol. i. Plate VII. Professor Keith notifies the following errata in the lithographed computation:—

In the elements furnished by Mr. Tolles, $r - 0.29$ should be $r - 0.029$, and in the fourth column of figures, seventeenth line from the top, $55^\circ 5' 51''$ should be $55^\circ 5' 21''$.

XVII. — *Note on Mr. Wenham's paper "On the Measurement of the Angle of Aperture of Objectives."* By Professor R. KEITH.

(Read 12th February, 1879.)

MR. WENHAM, in a paper read November, 1878,* seems to apprehend the interference of outside light in the ordinary process of measuring angular aperture, but his attempt to explain this interference fails to show where his difficulty is. His figure has no meaning in connection with the subject, as the outside legs of the tripod will not after refraction come to the same point in the field of the Microscope that the central one does, and therefore have nothing to do with the measurement. They will, of course, after refraction fall far to the right and left of the centre, and have nothing to do with the aperture question. One point in the image corresponding to one point in the object, *and one only*, is to be considered in making the measurement for aperture. It is true that with the sector as ordinarily used, first one edge of a lamp flame is brought to the centre of the field, and then the other edge: but the few minutes of arc subtended by the flame are, strictly, to be subtracted from the reading of the sector, thus practically making one edge of the flame only the object of consideration.

Those interested will bear in mind that in measuring aperture with the sector, the lamp flame is placed far enough away to render the rays of light sensibly parallel. The Microscope tube is then inclined to the direction of the lamp flame, until the outside ray of the flame is bent along the axis to the centre of the field, and the sector read. The tube is then again inclined to the direction of the flame on the opposite side until the outside ray of the flame is again bent along the axis to the centre of the field, and the sector again read.

Half the difference of the readings gives practically the exact amount by which the ray of light is bent. The whole difference is under these circumstances the angular aperture, and if two lights be placed so that their directions will form that angle at the objective, both lights will be visible at the same time in the Microscope. Whether the lights give but a single ray or a large bundle of parallel rays, the result will be the same. Any allusion to outside rays as interfering in this simple process is therefore erroneous.

* Vol. i. p. 321.

XVIII.—*Reply to the foregoing Note.*

By F. H. WENHAM, F.R.M.S.

(Read 9th April, 1879.)

As those who have been engaged in the aperture controversy have explained their meaning repeatedly, I quite agree with what I understand is the view of the Council, that it should now be closed till some new fact appears to elucidate the question.

Professor Keith's Note does not call for discussion, as the objections appear to arise from a misapprehension of the acting conditions of the sector measurement. The flame does not remain in the centre of the field of the eye-piece during the traverse, and there is no axial bisection; the least movement sideways causes the image of the lamp to leave the centre, and when at last the light margin divides the field, the half illumination is actually caused from the eclipse of the light by the edge of the eye-piece stop. The position of the distant flame can be seen with an "examining lens" over the eye-piece. The field is traversed by the beam of light; this successively intersects all the oblique pencils of the object-glass which afterwards enter together in proximity at the eye-piece at a very small angle of divergence.

The sector measurement fails to indicate true angles of aperture, and in order to prove this without theorizing, I described in my last paper a plain and unmistakable demonstration. I took a series of decisive angles of aperture by the "triangle" method, viz. from the focal distance up to a definite diameter of front lens; I then measured the angle from each of these restricted diameters or apertures by the sector, employed precisely in the ordinary manner, and tabulated the comparative results as "false apertures."

With this I am content to allow all personal controversy to remain at rest, as I consider that I have clearly proved that angle of aperture is usually measured greatly in excess, as angle of field.

NOTES AND MEMORANDA.

It is intended in future numbers of the Journal to classify the Notes and Memoranda and Bibliography as shown below,* by which plan it is believed that the value of the Journal as a scientific record will be enhanced.

ZOOLOGY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE VERTEBRATA.

B. INVERTEBRATA.

For Bibliography only.	{	(a) PROTOZOA.
		(b) PORIFERA.
		(c) CŒLENTERATA.
		(d) ECHINODERMATA.
		(e) VERMES.
		(f) ARTHROPODA.
		(α) CRUSTACEA.
		(β) ARACHNIDA.
		(γ) MYRIAPODA.
		(δ) INSECTA.†
		(g) MOLLUSCOIDA.
		(h) MOLLUSCA.

BOTANY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE PHANEROGAMIA.

B. CRYPTOGRAMIA.

For Bibliography only.	{	(a) ALGÆ.
		(b) LICHENES.
		(c) FUNGI.
		(d) CHARACEÆ.
		(e) MUSCINEÆ.
		(f) VASCULAR CRYPTOGAMS.

MICROSCOPY.

(Instrumental—Methods, Reagents, &c.)

ZOOLOGY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE VERTEBRATA.

Nuclei of the Blood-corpuscles of the Triton.—Urged by the publication of Stricker's researches, according to which the nuclei of

* We are aware that this classification is more or less open to criticism, but we have adopted it as being on the whole the most convenient for this particular purpose at least.

† It is not proposed to deal exhaustively with the Insects; that branch of the Animal Kingdom being already well provided both with journals and special societies.

the corpuscles are not constant structures, M. Pouchet has made some observations,* of which the following are the chief conclusions:—

(1) The red and white corpuscles are derived from the same anatomical elements. (2) The nuclei of the white corpuscles undergo complete segmentation, but (3) this segmentation does not occur so long as they are freely suspended and moving in the serum. (4) The red corpuscles are “final elementary forms.” (5) The so-called reticulum in these corpuscles of the Triton is merely the result of the partial division of the substance of the nucleus. (6) In development these nuclei reach a certain maximum size, and then decrease. (7) The red blood-corpuscles themselves disappear by dissolution in the serum. (8) There is no fissiparous multiplication of red blood-corpuscles after that these bodies become provided with hæmoglobin. (9) As is well known, the red corpuscles may be discoid or ovoid in shape, and it is suggested that there is some relation between these two forms and the molecular state of the contained hæmoglobin. The nucleolus of the corpuscles is defined as being that point, or those points, which have a greater “elective affinity” for carmine. The paper is illustrated by a plate of sixteen figures.

Division of Cartilage Cells.—An important research on this subject is published by W. Schleicher,† whose results agree in the main with those of Flemming,‡ but differ in many points not wholly unimportant. Schleicher denies the presence of a true intranuclear network, but describes rods, fibres, and granules (Stäbchen, Fädchen, und Körner), as existing within the nucleus. The first step in the division of a cartilage cell consists in the disintegration of the nuclear membrane; next, the contents of the nucleus—the rods, &c., undergo an extraordinary series of changes of form and position, the whole nucleus at the same time constantly changing its position. After a time, the rods, &c., take on a more or less parallel arrangement, and then, becoming approximated at their extremities, form a more or less fusiform figure, corresponding to the spindle-nucleus of other observers. The approximated ends of the rods then fuse together, and division takes place along a plane taken through the centre, and perpendicular to the long axis of the spindle. The nuclei of the two daughter-cells are thus produced; each of these becomes resolved into rods and fibres, these undergo changes of form, and, at length, those situated towards the periphery of the nucleus curve round and fuse with one another, forming a new nuclear membrane. In the membraneless state of the nucleus a connection was observed between its fibres and those occurring in the protoplasm of the cell—the intracellular network of other authors. Some observations made tended to the opinion that the intracellular fibres arose, by a process of delamination, from the capsule of the cell.

Influence of the different Colours of the Spectrum on Animals.—The article of M. E. Yung, of which we gave an abstract (from

* Robin's 'Journ. Anat. et Phys.,' xv. (1879) 9.

† 'Archiv. f. Mikr. Anat.,' xvi. (1878) 215.

‡ This Journal, ii. (1879) 137.

'Comptes Rendus') at p. 138, has now been published in Professor Lacaze-Duthiers' 'Archives,'* where it occupies thirty-two pages.

B. INVERTEBRATA.

Formation, Fructification, and Division of the Animal Ovum.—This subject is treated of in two papers by Oscar Hertwig,† each illustrated by three plates. He works out very fully for Echinoderms, Worms, Coelenterates and Molluscs, the important questions of the fate of the germinal vesicle, the formation of the "polar cells," the precise phenomena attending impregnation, and the mode of formation of the first cleavage-nucleus of the fertilized egg. His results are for the most part confirmatory of his former observations,‡ and are briefly as follows :—

Before impregnation, the germinal vesicle becomes profoundly altered; its membrane disappears, and itself assumes a spindle form, with the usual radiation of granules from its poles. It then approaches the periphery of the egg, and one end of it passes into a small prominence on the surface of the latter. The spindle then divides in the usual way, one part remaining in the egg proper, the other in the prominence, which now becomes separated off as the first polar cell. The same process is gone through once more, and another polar cell formed. The portion of the nucleus still left in the egg now undergoes a change, becoming converted into a rounded body—the female pronucleus—surrounded by radiating granules. At about this time, or somewhat before, fertilization takes place, usually a single spermatozoon making its way into the vitellus, whereupon its tail undergoes absorption and its head is converted into a body—the male pronucleus—closely resembling the female pronucleus. The two pronuclei travel towards one another, coalesce, and produce by this process of conjugation, the first cleavage-nucleus of the impregnated egg.

Digestion of Albuminoids by Invertebrata.—The researches of Dr. Fredericq have been directed to Annelids, a cestoid Worm, Molluscs, Ascidians, a Bryozoon, an Echinoderm, a Coelenterate and some Sponges. He treats the digestive organs of the animal, if they are large enough to be isolated, with alcohol. If the animals are too small he places a considerable number of them entire in the alcohol, which coagulates the albuminoid bodies, sparing the ferments. The objects thus treated are dried and pulverized, and the powder should contain the ferments. To distinguish them, one part of the powder is infused in distilled water, another part in water acidulated with muriatic acid, and a third with water alkalized by carbonate of soda. A piece of fibrin placed in the different liquids, heated to 40°, indicates by its solution or resistance the presence or absence of ferments analogous to pepsine or thrypsine.

The general result was found to be that the transformation of aliments is effected in the Invertebrata by digestive ferments analogous to those of the Vertebrata.§

* Vol. vii. (1878) 251.

† 'Morphol. Jahrb.,' iv. (1878) 156 and 177.

‡ See Balfour, in 'Quart. Journ. Mikr. Sci.,' xviii. (1878).

§ 'Bull. Acad. Roy. Sci. Belg.,' xlvi. (1878); 'Rev. Internat. des Sci.,' iii. (1879) 80.

Eozoon Canadense.—Dr. Dawson, F.R.S., writing on Professor Möbius' recent treatise, says * that *Eozoon Canadense* has since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of, another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralized with silicates, traversed with minute mineral veins, faulted, crushed and partly defaced, as is the case with most specimens of *Eozoon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a much more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozoon* in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. He has seen in the collections of dealers and even in public museums, specimens labelled "*Eozoon Canadense*" which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid.

The memoir of Professor Möbius affords illustrations of some of these difficulties in the study of *Eozoon*. Professor Möbius is a zoologist, a good microscopist, fairly acquainted with modern foraminifera, and a conscientious observer: but he has had no means of knowing the geological relations and mode of occurrence of *Eozoon*, and he has had access merely to a limited number of specimens mineralized with serpentine. These he has elaborately studied, has made careful drawings of portions of their structures, and has described these with some degree of accuracy; and his memoir has been profusely illustrated with figures on a large scale. This, and the fact of the memoir appearing where it does (*Palæontographica*), convey the impression of an exhaustive study of the subject; and since the conclusion is adverse to the organic character of *Eozoon*, this paper may be expected, in the opinion of many not fully acquainted with the evidence, to be regarded as a final decision against its animal nature. Yet, however commendable the researches of Möbius may be, when viewed as the studies of a naturalist desirous of satisfying himself on the evidence of the material he may have at command, they furnish only another illustration of partial and imperfect investigation, quite unreliable as a verdict on the questions in hand.

Dr. Dawson then "indicates the weak points of the memoir," of which the following is a summary.

* 'Am. Jour. Sci. and Arts,' xvii. (1879) 196.

1. There are errors and omissions from want of study of the fossil *in situ*, and from want of acquaintance with its various states of preservation.

2. He confounds the finely tubulated proper wall of *Eozoon* with the chrysotile veins traversing many of the specimens and obviously more recent than the bodies whose fissures they fill.

3. In regard to the canal system, he thinks that the round and regularly branching forms which he figures, and which nearly resemble the similar parts of modern Foraminifera, are rather exceptional, which is a mistake.

4. A fatal defect in his mode of treatment is that he regards each of the structures separately, and does not sufficiently consider their cumulative force when taken together.

Reticularian Rhizopoda.—Mr. H. B. Brady, F.R.S., in notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition,* referring to Carpenter, Parker, and Jones's 'Introduction to the Study of the Foraminifera,' the work of Professor Reuss, and the more recent suggestions of Professor Zittel and Professor T. Rupert Jones, as to classification, says that it is not altogether satisfactory to have to depend solely upon the structure and conformation of the external skeleton or test for distinctive characters. There can scarcely be a doubt that the sarcode bodies of animals varying so much in their features must have important differences. The researches of R. Hertwig on the animal of *Miliola* and *Rotalia*,† and those of F. E. Schulze‡ on *Polystomella* and *Lagena*, permit no longer the belief that the Reticularian Rhizopoda consist of mere masses of undifferentiated protoplasm, and a wide field of investigation is thereby opened, in which the employment of chemical reagents, in conjunction with the higher powers of the Microscope, may be expected to yield a harvest of hitherto unnoted facts. But for these methods of research the fresh, if not the living animal must be used; material long preserved in alcohol, as the 'Challenger' dredgings have necessarily been, furnishes only the knowledge derivable from the harder tissues, and the portions rendered permanent by inorganic constituents.

Protozoa of Northern Russia.—An elaborate paper on this subject, illustrated by two plates, by C. von Mereschkowsky,§ gives the results, as far as Protozoa are concerned, of his two journeys to the White Sea, made in the summers of 1876 and 1877.

1. *Proposed new Family.*—Mereschkowsky proposes to form into the new family *Uvellina* those colonial monads the individuals of which are provided with one or more cilia, are devoid of a lorica, but sometimes enclosed in a common gelatinous investment, are not united into a branched colony, but form more or less spherical masses, and for the most part (*Anthophysa* is an exception) are free-swimming. They may, in the author's opinion, be taken as transition forms

* 'Quart. Journ. Mier. Sci.,' xix. (1879) 24.

† 'Jenaische Zeitschrift für Naturwiss.,' x. 42.

‡ 'Archiv für Mikr. Anat.,' xiii.

§ *Ibid.*, xvi. (1879) 153.

between unicellular and multicellular animals, and indeed as representing permanent *Morulae*. Multiplication takes place, in fact, by the separation of a monadiform cell and its division into 2, 4, 8, &c., masses, by a process exactly resembling the segmentation of the egg-cell in a Metazoon. *Polytoma uvella* is not included in this family, since the morula form is not permanent, but breaks up into separate individuals.

2. *New Genera*.—The following three genera are described as being new to science. *Merotricha* (*M. bacillata*), a regularly oval uniflagellate monad; *Urceolus* (*U. Alenizini*), another uniflagellate monad, with transparent collar-like œsophagus; and *Haeckelina** (*H. borealis*), a beautiful and highly interesting marine Moneron, which seems to bear much the same sort of relation to the *Tentaculifera* (*Acineta*, *Podophyra*, &c.), as *Protamœba* bears to *Amœba*, *Myxastrum* to the *Gregarinidæ* and *Protomonas* to the monads.† It consists of a globular colourless body, capable of very slight changes of form, devoid of vacuole or nucleus but containing various granules. Its surface is closely beset with a great number of very delicate stiff pseudopodia, standing out at right angles to its surface, and about equal in length to the diameter of the body. The body is seated on one end of a stem, the other extremity of which is attached to foreign bodies (algæ). The stem is long, slender, transparent, and solid, being quite devoid of an axial "muscle." Nothing is known of the reproduction of this interesting species.

3. *New Species*.—The author describes a large number of new species, which our space merely allows us to enumerate. They are *Cothurnia arcuata* (marine), *Vorticella pyrum* (do.), *Zoothamnium marinum* (do.), *Epistylis balanorum* (do.), *Tintinnus Ussowi* (do.), *Oxytricha Wrzesniewskii* (do.), *O. oculata* (do.), *Aspidisca Andreewi* (do.), *Balanitidium* (?) *medusarum* (do.), *Glaucoma Wrzesniewskii* (fresh-water), *Holophrya Kessleri* (do.), *Podophyra* (*Acineta*) *conipes* (marine), *Dinophysis arctica* (do.), *Heteromita sulcata* (fresh-water), *H. cylindrica* (marine), *H. adunca* (do.), *Clathrulina Cienkowski* (fresh-water), *Pleurophrys angulata* (do.), *Diffugia Solowetskii*, *Hyalodiscus Korotnewi* (marine), *Amœba minuta* (do.), *A. papillata* (fresh-water), *A. angulata* (do.), *A. Jelaginia* (do.), *A. emittens* (do.), *A. alveolata* (marine), *A. filifera* (do.), and *Protamœba Grimmi* (do.).

4. *Geographical Distribution of Infusoria*.—The author sums up his remarks on this question in the form of three propositions. He considers it well established, firstly, that the marine Infusorial fauna, being exposed, like any other animal fauna, to the influence of external conditions, is wholly different to that of fresh water. Secondly, that the infusorial (protozoic) faunæ of different seas, distinguished from one another by unlike conditions, are themselves different, and this difference is of the same character as that existing in any group of the higher animals. Thirdly, that the

* This name has been applied by Bessels to Sandahl's *Astrorhiza*. See 'Quart. Journ. Micr. Sci.,' xvi. 221.

† See the table on p. 677 of Huxley's 'Invertebrata,' giving the relations of the various genera of *Monera* to the groups of *Endoplastica*. The discovery of *Haeckelina* fills up an important gap in this scheme.

marine protozoic fauna differs far more in different seas than does the fresh-water protozoic fauna in different terrestrial regions.

Deep-sea Siphonophora.—The *Siphonophora* have always been held to be an exclusively surface group; it is therefore of great interest to find species of the sub-order occurring at great depths. Professor Studer of Bern gives an account* of two well-marked species brought up during the voyage of the corvette 'Gazelle,' from depths of 1500–2000 fathoms in the Atlantic Ocean. Both species belong to the genus *Rhizophysa*, and are named by Studer *R. conifera* and *R. inermis*. Full descriptions, illustrated by three plates, are given of both forms, as well as of some fragmentary specimens of other *Siphonophora* found at the same time.

Strange Anomaly among the Hydromedusæ.—In the 'Transactions of the Society of Naturalists of St. Petersburg,'† a new species of small naked-eyed Medusa, from the White Sea, is described, which Mereschkowsky has named *Bougainvillea paradoxa*, and which (with another species of the same genus) presents a strange anomaly pretty frequently observed amongst the normal individuals.

The adult animal does not much exceed 1 cm. in length, and its form is that of a bell slightly contracted at its aperture, with four radiating canals, each furnished at its extremity with a tuft of from three to seven tentacles and with a red ocellus. The deep red manubrium has from above the form of a cross, from each of the four ends of which starts a radiating canal. Round the mouth there is a circle of four tentacles dividing dichotomously into a great number of branches. It is remarkable that the ova are developed immediately on the surface of the manubrium, so that the latter when the ova have become converted into planulæ acquires a tuberculate aspect, caused by a great quantity of planulæ forming a layer covering its surface, with one of their ends projecting freely, and the other attached to the wall of the manubrium.

Some forms (undoubtedly of this same animal) are distinguished by the total absence of the coloured manubrium. It was thought that there might be some atrophy of the organ, but remains of it were sought for in vain. The whole gastro-vascular system consisted only of a circular canal and of the four radial canals, which were united at the summit without forming anything resembling a stomach. Moreover, although in other respects of normal conformation, it had absolutely no opening to the exterior, no buccal or other aperture which might establish a communication with the circumambient water.

This fact is the stranger because these anomalies are observed in Medusæ which are but very little exceeded in size by the normal adult individuals. They consequently have been able to nourish themselves, since from microscopic embryos they have attained a size of more than half a centimetre.

M. Mereschkowsky considers that the only probable hypothesis to account for the development of a complete Medusa, without the aid

* 'Zeitschrift f. wiss. Zool.,' xxxi. (1878) 1.

† 'Protocoles de la Réunion du 14 Jan. 1878,' ix. 33.

of organs of nutrition, is that the ectoderm fulfils the function of the entoderm, and the animal nourishes itself by its ectoderm absorbing the organic material dissolved in sea water, a supposition the more probable as he has already demonstrated the same fact in sponges.*

Muscle-epithelium in Anthozoa.—Dr. O. Kling publishes a preliminary communication on this subject,† in which he studies the exact relation of the so-called neuro-muscle cells in the genera *Actinozoa*, namely *Actinia (equina)* and *Muricia*. In both these genera he finds that the muscular layer occurs on the inner (endodermal) side of the supporting lamella, and that the cells of which it is composed are in evident connection with the endodermal cells.

The arrangement in these forms is therefore the exact opposite to those which obtain in *Hydra*, in which, as Kleinenberg showed, the neuro-muscular cells are undoubtedly ectodermal. This seems to show that the mesoderm, like the generative products, may have originally sprung indifferently from either layer.

Phylogeny of the Antipatharia.—This subject is discussed in a paper‡ by G. v. Koch, who begins with a description of *Antipathes larix* and *Gephyra Dohrnii*, and afterwards discusses the probable steps in the evolution of the *Antipatharia*, which he considers to have been as follows:—

1. Soft-bodied *Actiniæ* secreted a horny substance from the ectoderm of the disk of attachment.

2. Those of the foregoing forms, which were attached to thin cylindrical supports, surrounded the latter and covered them with a horny substance, which, in the case of polypes occurring in large groups, served to unite them by their bases.

3. These polypes, living singly or in groups, became united, by means of stolons, into a colony. The axial skeleton no longer existed exclusively as an investment to some support, but gave off independent branches.

4. The separate parts of the polypes underwent retrogression.

5. The colonies (zoanthodemes) assumed a greater independence of form, while the axial skeleton no longer retained the form of an investment of a foreign support. The polypes decreased in size concomitantly with the increase of their numbers on one colony; with this diminution in size was connected arrest of the mesenteries and tentacles.

Skeleton of the Alcyonaria.—A study of this interesting group of *Actinozoa* has been made by v. Koch.§ In the first part of the paper the author gives a description of the anatomical character of the following genera and species:—*Sclerogonia Mexicana*, *Mopsea erythræa*, *Melithæa*, *Muricea placomus*, *Isis elongata*, *Primnoa verticillaris*, *Pennatula rubra*, *Halisceptrum Gustavianum*, and *Kophobelemnon Leuckartii*.

The second part is occupied with a description of the skeleton of

* 'Ann. and Mag. of Nat. Hist.,' iii. (1879) 177.

† 'Morphol. Jahrb.,' iv. (1878) 327.

‡ Ibid., iv. (1878) 74.

§ Ibid., iv. (1878) 447.

Alcyonaria, and begins with a brief general description of the skeleton of *Actinozoa*. This may occur in either of the following positions :—

- | | | |
|--|---|---------------|
| 1. On the free (inner) surface of the entoderm | } | Entoskeleton. |
| 2. Within the entoderm | | |
| 3. Between the entoderm and ectoderm— | | |
| a. Secreted from entoderm cells only .. | } | Mesoskeleton. |
| b. From both layers | | |
| c. From ectoderm cells only | | |
| 4. Within the ectoderm | } | Ectoskeleton. |
| 5. On the free (outer) surface of the ectoderm | | |

Of these only the third and fifth kinds occur in *Alcyonaria*.

The mesoskeleton in the simple forms consists of "a thinner or thicker layer between the ectoderm and entoderm, which, after removal of all the cellular elements of the body, retains the form of the polype, since it extends between all the folds of the two primary cell-layers."

In those compound forms which have the polypes connected by stolons, the mesoskeleton exists in the form of a thin lamella between the two layers of the stolons. In the species in which the polypes are united into a broad plate-like colony by means of a solid mass or cœnenchyma, the greater part of the latter is formed by the mesoskeleton, which is covered externally by ectoderm, while within are contained the nutritive canals, lined with entoderm, by means of which the polypes are placed in communication with one another.

In a few forms, the mesoskeleton consists merely of a hyaline or fibrillar substance (*Monoxenia*, *Cornularia*). In other cases calcifications or spicules are developed, the arrangement of which differs greatly, both in various portions of the same polype or of the same zoanthodeme, and in the various genera and species. The spicules are often scattered singly in the hyaline matrix, but often, on the other hand, exist in such great numbers as to give the whole skeleton a firm, cork-like consistency, its form being then but slightly altered by drying. In many cases the separate spicules undergo fusion, and form a firm continuous framework, which may replace, to a greater or less extent, the hyaline matrix (*Tubipora*, *Pseudaxonia*). In a few forms there is a continuous mesoskeleton, not due to the fusion of originally distinct calcifications. The free part of the polypes and the peripheral portions of the zoanthodeme never undergo conversion into horn, but only the so-called axis (pseudaxis, Koch). Calcification of the horny interstitial substance has not been made out in *Alcyonaria*.

An ectoskeleton occurs only in the tree-like zoanthodeme, and probably also in *Pennatulidæ*. As far as is known, it consists of a secretion of the ectoderm cells of the attached surface; this secretion increasing with the growth of the colony, forms a horny more or less calcified axis (the sclerobase). Frequently cavities occur in the horny substance, filled either with a spongy material (*Gorgonia*, *Muricea*), or by a crystalline substance, rich in calcific matter (*Plexaurella*). Often there is an alternation of horny and calcareous lamellæ, and in many species the whole axis is formed of alternate horny and calcareous pieces. On the other hand, the horny substance may be uniformly impregnated with calcic carbonate, but spicules never occur in the ectoskeleton. The central part of the axis may remain empty

or be filled up with spongy tissue traversed by cross-partitions; secondary, calcific masses may also be found in the cavities of the axis.

The third part of the paper is classificatory: the author divides the various families of the *Aleyonaria* into three chief groups, as follows:—

I.—Polypes never united into a colony.

Fam. 1. *Haimaida*.

II.—Colonies are formed, but the individual polypes remain independent, and are only united by stolons or by plate-like expansions.

Fam. 2. *Cornularida*.—Spicules separate.

„ 3. *Tubiporida*.—Spicules united into a continuous skeleton.

III.—The cœnenchyma is well developed, and the polypes appear only as organs of the colony.

a. Mesoskeleton only developed.

Fam. 4. *Aleyonida*.—Skeleton spicular.

„ 5. *Pseudaxonia*.—Skeleton continuous.

„ 6. *Helisporida*.—Main part of skeleton calcified; no spicules.

b. Both meso- and ectoskeleton developed.

Fam. 7. *Pennatulida*.—Free-swimming; digestive cavities long.

„ 8. *Axifera*.—Fixed; digestive cavities short.

New Species of Isis.—A new species—*Isis Neapolitana*—of the interesting Aleyonarian order *Isidaceæ* has been recently discovered by v. Koch, who gives an account of its anatomy,* together with the following diagnosis:—

“Polypary about 1 metre high, ramified, attached to rocks, &c. by means of an irregularly lobed basal plate, branches springing from the horny internodes. Calcareous joints of the axial skeleton white, cylindrical; on the thicker stems about 8 mm.; on thinner branches about 16 mm. long, strongly ribbed. Internodes dark brown, becoming shortened on the decrease in thickness of the stem, from 2.5 mm. to 0.3 mm. in length. Cœnenchyma thin, greyish-white, containing calcareous spicules only in the bases of the polypes. Nutrient canals twice as numerous as the longitudinal grooves on the calcareous joints. Polypes scattered over the branches, about 3 mm. long, well provided with smaller and larger spicules; outer wall of tentacles also containing spicules. Polypes very slightly contractile. Habitat, Gulf of Naples.

The paper is accompanied by a plate, illustrating the anatomy of the species.

Gorgonia verrucosa.—In a short paper on the anatomy of this species,† v. Koch records the important discovery of a layer of epithelial cells between the horny axis of the zoanthodeme and the cœnenchyma. He has found the same thing in other *Gorgoniæ*, and considers it certain that, in some at least of the horny corals, the axial skeleton is a secretion of an epithelium derived, in all probability, from the ectoderm.

This discovery is of great interest, as, according to most observers, the axial skeleton of *Gorgonidæ* is formed from the connective tissue of the cœnenchyma; Koch himself, indeed, assigns this origin to it in *Isis*.

* ‘Morphol. Jahrb.’, iv. (1878) 112.

† Ibid., 269.

Prehensive Cells in the Ctenophora.—Dr. Carl Chun gives* an account of his observations on certain prehensive cells which have been observed in the *Ctenophora*; those which are found on the “grappling lines” of these forms were principally studied in *Cydidippe hormiphora*, Gegbr. The bodies in question were but $\frac{1}{100}$ of a millimetre in breadth, and were chiefly made up of gelatinous tissue, just as is the greater part of the body of these Cœlentera; they contain a filament, coiled into five or seven spires, which, when fully extended, has much the form of *Vorticella*; nor does the resemblance end here, for the thread may be seen to be provided with a muscular band, the functions of which are examined. The author corrects some of Clark’s observations on these so-called “Lasso-cells,” and, pointing out that they are not, like the ordinary thread-cells, set free from a containing cell, thanks to their elasticity, proposes to call them “Greif-zellen.” He adds that he has failed to find true stinging-cells (nematocysts) in the *Ctenophora*, and urges that they cannot be regarded as belonging to the Nematophorous group.

Australian Corals.—The Rev. J. E. Tenison-Woods, in the ‘Proceedings of the Linnean Society of New South Wales,’ † says that a study of the Australian living forms has shown that some of the fossil species thought to be extinct are still existing. They are *Trochocyathus Victorice* and *Sphenotrochus variolaris*. There are also forms which have a remarkable relation with extinct species, viz. *Conocyathus Zelandice*, which was not known as Australian, and which bears a strong resemblance to the extinct European Miocene form *C. sulcatus*. It would be almost useless to form any conclusions from the very few observations which have resulted in the discovery of a few new species, yet what has been discovered shows plainly what might be expected from an extended series of operations. So far as has been learned, the coral fauna of New Zealand is very distinct from the Australian. If the observations of Quoy and Gaimard are to be relied upon, the northern end of New Zealand possesses forms which are never found out of the tropics in Australia, and very far within the tropics as well—*Porites Gaimardii* and *Polyphyllia pelvis*. Among the simple corals *C. Zelandice* is the only form known as common to both Australia and New Zealand.

The only corals on the S. and S.E. coast of Australia which could in any sense be called reef-building forms are one or two species of *Stylaster* and one or two of *Plesiastrea*. Both of these are littoral and grow in tufts or small masses, but never in anything more than the merest patches.

Eleven new species are described and figured, for two of which the author has erected two new genera. One, *Dunocyathus (parasiticus)*, is a parasitic coral of minute size, growing on the base of the singular Polyzoary named by Professor Busk *Lunulites cancellata*; the other, *Crispatotrochus (inornatus)*, a form which approximates to *Ceratotrochus*, but differs in the absence of any special ornamentation on the

* ‘Zool. Anzeiger,’ i. (1878) 50.

† Vol. ii. (1878) 292: “Extratropical Corals of Australia.”

ribs and the wide, deep calice, with a large hispid and spongy columella and a broad attachment.

Amongst the new species the author has been able to add one to each of the remarkable and rare genera *Endopachys* (*Australiæ*), and *Heteropsammia* (*elliptica*). The author also in other papers describes a new species of *Psammoseris*—*P. cylicoides*,*—and of *Desmophyllum*—*D. quinarium*,†—the former with a plate of eight figures.

New Genus of Milleporidæ.—In the same publication the Rev. J. E. Tenison-Woods describes‡ a new genus of Milleporidæ, *Arachnopora*, the generic character being “zoothome parasitic spreading like a small thin web over other corals.” In the only species found (*A. argentea*) the substance of the zoothome (7 by 3 mm.) seems a quite transparent membrane, on which there is generally a very close arrangement of small silvery granules. It occurs parasitic on corals, filling up half of the calice and spreading from opposite septa like a spider’s web. It also spreads over the sides of the costæ, where it appears just like a snail’s track, on which some very fine white dust had been sparsely scattered. There are no calices on the outside.

New Genus of Starfishes.—Dr. J. Jullien describes§ a new genus *Marthasterias* allied to *Asterias*, and characterized by its four rows of ambulacral tubes, the reticulated character of the dorsal skeleton, five arms, the presence of spines in the membrane edging the marginal plates, and its pedunculated pedicellariæ: to the new species the name *foliacea* is given.

Some idea of its characters will be gathered from the fact that “an eminent zoologist” regarded it as an *Asterias glacialis* which had undergone violent compression; this theory is, however, negatived by the presence on the dorsal surface of fragments of *Retepora cellulosa*, which would not have been preserved had the animal undergone the accident suggested. The rows of ambulacral spines are moreover single, and not double as in *Asterias*; while the spines themselves are simply conical, and are without the median constriction observed in that common form. The habitat of the single specimen described is not quite certainly known, but it is stated to be the Adriatic; the presence of a young *Nassa reticulata* in its intestines, together with that of the above-mentioned bryozoan on its surface, seems to indicate sufficiently clearly that it is an inhabitant of some European sea.

Helminthology.—Linstow continues, in the ‘Archiv für Naturgeschichte,’|| his observations on Helminthology; the paper is purely technical, but it may be of interest to observe that this indefatigable observer here describes forty-two forms, of which twenty-four are new species. The last described is the curious *Sphærulearia bombi*, Dufour, and the author states that he has found in the roots of moss a Nematode form, which is very like it, though somewhat larger, and

* ‘Proc. Linnean Soc. N. S. Wales,’ iii. (1878) 8.

† Ibid., 17.

‡ Ibid., 6.

§ ‘Bull. Soc. Zool. de France,’ iii. (1878) 141.

|| xliv. (1878) 218.

with a thicker caudal region. In the genus *Ascaris* there are two series of larval forms, one with and one without a boring denticle; of the former series the larvæ of *A. capsularia*, *A. eperlani*, and *A. communis* are of a relatively enormous size. The paper is illustrated by three plates.

Excretory Apparatus of *Solenophorus megalocephalus*. — M. J. Poirier* having some *Solenophora*, which had only remained a short time in alcohol, injected their excretory apparatus, and on examining the result saw that it did not agree with what had been hitherto published.

Instead of two longitudinal vessels on each side of the segments (the mode of communication between them not having been hitherto noticed), M. Poirier found, as in *Duthiersia*, six such vessels. The two internal ones alone communicate with each other by transverse canals, situated, as in all the Cestoids, at the commencement of each segment. These vessels, which (with the exception of the internal ones) have in the segments no direct communication with each other, in the scolex form a network which unites them. The external vessel, when it reaches the scolex, buries itself more deeply, passing under the two others and going along the groove which separates the two bothridia, towards the extremity of the scolex; there it divides into two branches, which ramify in each bothridium. The median vessel, of a smaller calibre than that of the two others, passes above the external vessel, and about the middle of the length of the scolex bifurcates into two branches which unite to the network formed by the divided branches of the external vessel.

The internal vessel bifurcates immediately after its entrance into the head, and forms a network of very large meshes which is joined to the network of smaller meshes arising from the external vessel. These three pairs of vessels therefore only form one system.

Besides the above vessels, which are of a considerable size, we find on the surface of the body, a second system of fine vessels, which M. Blanchard pointed out some time ago in the *Tæniæ* as a circulatory apparatus, and whose existence Gegenbauer denies altogether in his 'Comparative Anatomy.' These vessels, which are very fine, form on the surface of the segments and of the scolex a network of rectangular meshes, much closer in the *Solenophora* than in the *Tæniæ*, in which the longitudinal vessels of this network are few in number, as M. Blanchard has shown in *Tænia solium*, and as M. Poirier has proved in *T. crassicollis* of the cat. This network is only interrupted around the genital orifices: according to M. Blanchard it is completely isolated, but in reality communicates with the preceding system. Indeed, in the posterior part of each segment, the external vessel of the first system sends out a branch as far as the edge of the segment, and there produces ramifications which go into the external longitudinal vessels of the second system. The other vessels of the first system have no communication with these fine peripheral vessels; but, as they reunite in the scolex with the external vessel, it follows

* 'Comptes Rendus,' lxxvii. (1878) 1043.

that the two systems communicate and only form one single apparatus.

The fine peripheral vessels communicate by very fine and very short vessels with the calcareous corpuscles scattered over the surface of the body.

The apparatus must therefore be an excretory apparatus. It might perhaps also serve as an organ of absorption and nutrition, the fine peripheral vessels conducting the absorbed products into the large vessels, which would distribute them into the deeper parts of the organism.

Anatomy and Embryogeny of the Tæniadæ.—A preliminary communication on this subject by M. Monier * is chiefly a revision or criticism of the results of Sommer on *T. mediocanellata* and *T. solium*; the author justly observes that the excellent work of the German helminthologist seemed to be one which would be for a long time accepted as classical. The mother-cells of the spermatozooids are formed in the midst of a mass of central tissue, and there are no proper seminal ducts through which they may escape; this explains why they are provided with that long and apparently useless flagellum. What seminal tubes there are, are formed by a kind of excretion around the bundles of spermatozooids, and do not ordinarily become easily visible, except when, as in *T. cerebralis*, they are pigmented. In some species there appear to be two sets of spermatozooids, which become mature at different periods. The uterus does not receive the ova, which are formed in just the same place and in just the same way as the spermatozooids.

The *Hauptdotter* and *Nebendotter* of Sommer are stated to be merely extended ectodermal masses, one of which—the former—sometimes forms a kind of envelope for the egg. The so-called circular muscular layer is, in the young, found to give off fibres to the interior and to the exterior; these fibres are separated peripherally and unite at their centre to form the “parenchyma”; where they join the cuticle they form a very dense layer. Further observations are promised.

Parasites of the Lamellibranchiata.—Ulicny † gives an account of some observations on these parasites.

In *Cyclas rivicola* he finds a form of which little seems to be known, although it appears to be the *Cercaria Cycladis rivicolæ* of Diesing. These forms, which were found in sporocysts, imbedded in the generative organs of their host, were, thanks to their tail, capable of a large amount of movement; they are provided with a terminal oval sucker, above which there is a spine; in the anterior part of the last third of the body is placed the ventral sucker, which is as broad as the body. The most interesting region is the terminal or caudal portion. Connected by a narrow stalk with the end of the body there is a pyriform bulb, the surface of which is thrown into a number of folds; the interior of this enlargement is filled with a thick fluid, in which small vacuoles may be frequently observed, and

* ‘Rev. Internat. des Sci.,’ ii. (1878) 689.

† ‘Arch. für Naturgeschichte,’ xlv. (1878) 211.

it is also enclosed in a still larger bladder; the walls of this investment are invaginated at the anterior end, so as to form an aperture through which the body of the *Cercaria* can be protruded; on the other hand, the whole of the creature may be at times observed to be retracted within this envelope. With regard to this last no explanation is offered, but it is noted as non-existent in *Cercaria macrocerca*, although the tail of this form has a proper investment.

The author makes some observations on the species of *Bucephalus* which infest members of the same division of the Mollusca; two forms, *B. polymorphus*, Baer, which lives in the reproductive organs of Anodon, and *B. laimeanus*, Lacaze-Duthiers, which is found in marine forms, *Cardium* and *Ostrea*, are already known; a third, which as standing between the other two is very appropriately named *B. intermedius*, is now described; it was found in *Anodonta cellensis*, and the peculiarities of its structure are associated with its caudal region. In *B. polymorphus* the body terminates in a compressed and more or less biscuit-shaped bulbous enlargement, the broad end of which is attached to the body of the worm; the tail connected with this bulb, in which, it should be said, two portions can be made out, is eminently variable in form owing to its great power of contractility; in the new species the two parts are more distinctly differentiated and are separated by a constriction, but the caudal portion is constantly cylindrical in shape, and its only power of change is limited to its greater or less extension. When several forms get together they are able to form, with their tails, a veritable Gordian knot, which no instrument can unloose; in this point it differs very markedly from *B. polymorphus*, the tail of which can by very slight excitation be brought to change its form.

New Turbellarian.—The sojourn of Mereschkowsky on the White Sea has at any rate produced an account of a most interesting Turbellarian, to which he has given the name of *Alauretta viridivestrum*.* The body of this creature was elongated, and broadest at its anterior end, and measured $\frac{8}{10}$ of a millimetre; all but the proboscis, which was green, was colourless, and fairly transparent. Seen from without there appear to be three segments, owing to the presence of two circular constrictions towards the posterior end. By the aid of fine short cilia the animal moves about rapidly; these cilia are found over the whole body, with the exception of the very anterior region, where a single seta on either side stands directed forwards and outwards. The integument is thick and is succeeded by two layers of the body wall; of these the inner one is the thicker, and is distinguished by giving off five projections into the body cavity, which give an appearance of metamerism, and to which the author gives at least their full weight.

The mouth is placed in the anterior part of the body, where it forms an ellipse-shaped cleft; the enteric tube is straight, and does not branch; the position of the anus is left in a little doubt. The nervous system is distinguished from that of all other Turbellaria, by the possession of a large number of bipolar and unipolar nerve-cells; the eyes are on either side of the nerve-centre.

* 'Arch. für Naturgeschichte,' xlv. (1879) 35.

The apparent segmentation of the form leads the author to inquire as to the possibility of his having had to do with a larval Annelid; all these forms, however, seem to agree in that they do not exhibit metameric segmentation till a late period, and at any rate not until they have developed setæ at points corresponding to, and apparently indicative of such segments; while the presence of sexual products in the forms observed militates against their being immature. Nor again does the metamerism seem to be due to gemmation, nor is it the first instance of such an arrangement; Busch recorded a case in 1851, the characters of which were in 1865 put by Metschnikoff in their true light, while the Russian naturalist took this opportunity of recording another example. The form appears to belong to the *Microstomeæ*.

The most interesting points in a new species of *Prostomium* (*P. boreale*) are the presence of a chitinous sabre-shaped spine, which is placed to one side of the penis, and appears to be an organ either of defence or offence, and of a collection of glandular bodies of uncertain function, set on either side of the base of the proboscis. In another new species (*P. papillatum*) Mereschkowsky observed the presence of six papilliform projections at the anterior end of the body, which serve undoubtedly as tactile organs.

In a new species of *Mesostomium*, which he dedicates to L. Graff, Mereschkowsky describes the presence of enlargements on the vessels, which did not however exhibit either contraction or pulsation, and the function of which remains obscure; they do not seem to have been hitherto observed in these forms.

The author also makes some remarks on *Dinophilus vorticoides*, Oscar Schmidt, and on the general Turbellaria-Fauna of the White Sea.

Digestive Organs of the Fresh-water Turbellarians. — Elias Metschnikoff, who in 1866 was able to confirm the results of Claparède, made three years earlier, as to the absence of an alimentary canal in some of the Rhabdocœlous Planarians, returns to the subject,* and points out that the results, which have been denied by Minot on à priori grounds, have been confirmed by Uljanin (1870), Salensky (1872), and much more lately by Graff. He further proceeds to consider how far this character is one that is peculiar to these forms, and which so impressed Uljanin as to lead him to give to them the name of *Acœla*, or whether it is not rather one that is essentially common to the whole of the Turbellaria.

His account of the modes of digestion in a fresh-water Turbellarian allied to *Mesostomium productum*, and in *M. Ehrenbergii*, is peculiarly interesting. The former presented a fairly irregularly arranged mass of digestive cells; in these cells he found not only urinary concretions, but other bodies which he feels compelled to regard as nutrient particles; in *M. Ehrenbergii*, which is transparent, he was able to trace the history of these particles more completely. The chief food of this worm is *Nais proboscidea*, and an hour after ingestion he was able to discover all the soft parts of the *Nais* in its enteric cells; the cuticle and its setæ alone remained in the lumen of the tube. To

* 'Zool. Anzeiger,' i. (1878) 387.

test the matter still more accurately he attempted to feed the *Mesostomium* with carmine, but in this he failed; the *Nais* was however less refractory, and he thus succeeded in getting some very distinct points of observation so soon as the prey had been devoured by the Turbellarian.

Two species of Planarians were fed with blood, and the corpuscles were soon observed in the cells of their enteric tube. From these observations only one conclusion is possible: there are Turbellaria which are either without any differentiated digestive system, or which have retained the primitive method of digestion, that namely of taking the nutrient particles into their enteric cells. On the other hand it is no less certain that there are forms in this group which have passed beyond this stage, and do not allow the nutriment to pass into the epithelial cells of the enteric canal until they have been subjected to the ordinary digestive process. These observations are, it should be observed, of great importance as affording an example of the like of which we cannot, in the present state of the evolution question, have too many; for it bears directly on that variation in function of parts morphologically the same, which must have occurred if the theory of evolution be a correct explanation of morphological facts.

Land Planarians.—Dr. Kennel states in the ‘*Zoologischer Anzeiger*,’* the results of his observations on *Fasciola terrestris*, O. F. M., and *Geodesmus bilineatus*, Metschnikoff, the two forms of Land Planarians found in Germany. He was fortunate enough to be able to get a specimen of the former which produced young whilst under observation, and he notes that these are almost completely white. His study of the generative organs leads him to pretty much the same results as did those of Moseley (on *Rhynchodemus*). The two ovaries are small rounded capsules, placed very near the anterior end of the body; of the testes there are from 22 to 24 pairs, set close together, and placed just behind the ovaries. The common efferent duct is to be found in the last third of the body, and on the ventral surface it leads into the narrow canal to which Minot has given the name of generative antrum; the vagina passes back from it and ends as a closed sac, but at the closed end there open into it on either side the oviducts; the uterus, which has also the form of a closed sac, opens into the vagina; the sheath for the penis is pear-shaped, and the well-developed penis is conical in shape.

The primitive vascular system of Moseley is regarded as forming the longitudinal nerves, and is said to be connected with a well-developed bilobed cerebrum.

Geodesmus has but a single pair of testes, and there is no cæcal sac on the vagina; the anterior end is not flat (Metschnikoff), but is deeply excavated on its ventral surface.

Marine Planarians.—Professor Goette gives in the same Journal † a short account of his observations on the development of Marine Planarians. He finds that in the freshly laid eggs of *Planaria*

* ‘*Zool. Anzeiger*,’ i. (1878) 26.

† *Ibid.*, 75.

Neapolitana the extrusion of two germinal vesicles precedes the segmentation of the yolk; this gives rise to four pear-shaped parts of equal size, which divide towards their narrower end into four ectodermal and four endodermal cells; the latter are at first the larger, but the ectodermal cells increase rapidly in size and form a cap over the others. The endodermal cells, as they multiply, become arranged in two rows, and gradually separate so as to form a cavity. The embryo is convex on its dorsal surface, and there is a median groove on the ventral; the whole larva is covered by cilia, of which there is a large tuft just in front of the eyes, and a smaller one at the hinder end. The animal at this stage has consequently very much the appearance of a *Pilidium*.

Goette, from the fact that there are certain Nemertines which cast their larval integument, like *Pilidium*, without having the form of this larva, and that there are *Dendrocæla* which pass through a *Pilidium* stage without undergoing any true metamorphosis, concludes that there are various modifications of this relatively simple process of development, and that the developmental history of the Nemertines may be referred to that of the *Dendrocæla*.

Organization and Development of the Oxyurids.—Dr. Osman Galeb made a communication last year to the French Association for the Advancement of Science on the Oxyurids found as parasites in insects, which is now published in Professor Lacaze-Duthiers' 'Archives.*' Dr. Galeb has found different species of parasites in different species of insects, notwithstanding the similarity of habit in the hosts, and he draws more particular attention to the mode of development, and to the genetic affinities of these parasitic forms.

The ova are easily studied owing to their great transparency; the germinal vesicle was not found to disappear at the period of segmentation, but to elongate and divide; and indeed it is not till after its segmentation that the egg begins to undergo the same process. The enteric tube is formed by two swellings, which gradually meet one another; the more anterior forms the œsophagus and the commencement of the intestine. The observations of the author on the development of the generative organs do not agree with those of Schneider; his later observations lead to the conclusion that these parts are formed by the proliferation of a cell in the abdominal region, and not by the division of the primitive cells into a central (ovarian) and a peripheral (investing and supporting) series.

M. Galeb believes that as the various species of *Orthoptera* and *Coleoptera* which he has studied have become differentiated from a parent form, the parasite of that parent form has likewise become differentiated into different species adapted to their varying hosts. With regard to these observations it may be interesting to draw attention to the fact that Mr. A. H. Garrod, the Prosector of the Zoological Society, has found a species of *Tænia* in the Rhinoceros from the Sonderbunds, which he regards as identical with the species of this parasite found by Professor Peters of Berlin and Mr. Garrod's

* 'Arch. Zool. Exp. and Gén.,' v. (1878).

predecessor in his office, Dr. Murie, in two quite distinct species of *Rhinoceros*.*

Researches on *Bonellia viridis*.—This interesting Gephyrean genus has been studied by F. Vejdovsky, who gives an account of the mode of formation of the eggs in the female, and of the organization of the male.†

1. *Formation of the Ova*.—The ovary is attached to a sort of peritoneal fold, and at its least developed end shows small accumulations of similar cells. Of these ova one, enlarging at the expense of the others, becomes the egg-cell; the sister-cells, or follicular cells, being gradually compressed and flattened until they form a mere secondary membrane to the egg, external to the vitelline membrane. Some of the sister-cells, however, do not take on the character of a follicular epithelium, but form a hollow cap over one pole of the egg, outside the follicle; these also gradually dwindle away as their substance is absorbed by the rapidly developing egg-cell, until finally they vanish altogether.

2. *Structure of the Male*.—The curious parasitic Turbellarium-like male of *Bonellia*, discovered by Kowalewsky, was found by Vejdovsky in the œsophagus of young females, as well as in the oviduct of sexually perfect females, and in the mud in which these live. It is a minute elongated creature, covered with a ciliated cuticle, and having a straight, widish alimentary canal opening by a mouth near the anterior end of the body, and contained in a body cavity; there is also an indistinct non-ganglionated ventral nerve-cord. The spermatozoa are formed from cells detached, as rounded aggregations, like those from which the eggs are produced, from the peritoneal membrane lining the body cavity. The spermatozoa pass by a ciliated funnel into a spacious vesicula seminalis, which lies on the dorsal side of the alimentary canal, and opens by an aperture at the anterior end of the body. The male excretory apparatus thus closely resembles that of the female, in which there is a ciliated funnel leading by a duct into a uterus in which the eggs are stored, and which opens externally by an oviduct. In both sexes, also, there is a pair of chitinous hooks in relation with the genital aperture: these were discovered in the male by Marion, who contributes a woodcut illustrating their position to Vejdovsky's paper, which is further accompanied by a plate.

The male of *Bonellia* is also treated of in a short paper by Selenka,‡ whose account differs in certain important respects from that given above. He denies the presence of a cuticle, and states that the external layer of the body is covered by ordinary ciliated cells. He denies also the presence of both mouth and anus, and describes the nervous system as possessing a distinct subœsophageal ganglion and circum-œsophageal ring. The animal also possesses, according to Selenka, a pair of segmental organs in the hinder third of the body. He remarks, in conclusion, upon the interest of *Bonellia* as affording one of the few cases of polyandry known in the animal kingdom; four to twelve or even twenty males being found in a single female.

* 'Proc. Zool. Soc.,' Nov. 1877.

† 'Zeitschr. f. wiss. Zool.,' xxx. (1879) 487.

‡ 'Zool. Anzeiger,' i. (1878) 120.

Development of Chætopoda.—The development of two species of *Serpula* (*S. uncinata* and *S. glomerata*) has been studied by Michael Stossich,* who sums up the results of his investigations as follows:—

1. The eggs of tube-worms undergo complete yolk-division.
2. From the blastula a gastrula is formed by invagination: the so-called blastopore passes directly into the permanent anus.
3. The cleavage cavity (blastoele) is filled with an albuminous or fatty fluid, exuded from the blastoderm-cells, which serves the purpose of a food-yolk.
4. The inner wall of the alimentary canal and the surface of the free-swimming larva are covered with cilia.
5. On the inner surface of the digestive canal are found two duplicatures marking the boundaries between œsophagus, stomach, and intestine.
6. The cleavage cavity undergoes conversion directly into the body cavity, in which, probably, at a later period, the mesoderm cells arise.
7. Above the anal aperture a vesicle (?) is formed, which is connected with the formation of the muscular system.
8. Underneath this "anal vesicle" the larvæ develop, at the end of the body, a tongue-shaped mass, by means of which they attach themselves to foreign bodies.

Parasitism of Notommata on Vaucheria.—R. Wollny, of Niederlössnitz, has made some recent observations on the mode in which this Rotifer is developed within the Vaucheria-cell.† The Vaucheria in which the development takes place is so weakened as to be unable to produce the reproductive organs; the part in which the ova are found being modified for the purpose of forming the swellings or galls within which the rotifer is developed from the ovum. The ova have the tendency to force themselves into the Vaucheria-tube through the canal which unites the gall to the tube, and do not escape directly from the gall. The tube either then decays in consequence of being deprived of nutriment, or the young rotifer forces its way through it. In a Vaucheria obtained from Rome, Wollny detected also galls of a slightly different character; but he had no opportunity of examining either the ova of the parasite or the perfect animal.

Kidney of the Fresh-water Crayfish.—An investigation on the curious "green-gland" of the Crayfish has been lately made by C. E. Wassiliew,‡ whose observations form an important contribution to our knowledge of that organ. He states that the gland consists of a single unbroken coiled tube, blind at one end, opening at the other into the sac of the gland or urinary bladder, and consisting of three distinct portions. The first of these has the form of a somewhat triangular yellowish-brown lobule, lying on the upper surface of the gland and forming the blind terminal portion of the whole tube; the second forms a green cake-shaped mass, constituting the lateral and inferior parts of the gland; while the third is a long, white, coiled

* 'Wiener Sitzungsab.,' lxxvii. (1878) 1 Abth. 533.

† 'Hedwigia,' xvii. (1878) 5 and 97.

‡ 'Zool. Anzeiger,' i. (1878).

tube, connected at the end with the green portion and by the other opening into the bladder.

The entire tubular gland is lined by a single layer of epithelial cells, outside which is a fine structureless tunica propria, containing strongly refracting nuclei. There is no cuticular lining to the tube, which thus differs very markedly from the Malpighian vessels of insects. In the yellow portion the cells are sharply defined and convex on their inner surface. In the green part of the tube the cells are large, and their protoplasm is in connection with a peculiar network of pseudopodial processes which extend into projections of the wall into the lumen of the tube. In the proximal portion (that nearest to the green section) of the white part of the tube the walls are smooth, and lined by small cells approaching the pavement form. In its distal portion mammilliform or dendritic processes of the wall project into the cavity, often giving the tube a spongy appearance, and the cells have long broad processes developed from their inner surfaces. The epithelium of the bladder agrees with that of the smooth portion of the tube.

The products of secretion are seen in the white and green but not in the yellow portion of the gland, as yellowish, rather highly refracting drops on the surface of the cells. Probably the yellow part secretes a substance soluble in alcohol. That part of the white tube with tessellated epithelium most likely acts merely as a duct.

The anterior portions of the gland and bladder are supplied by a branch of the antennary arteries, their posterior portions by the sternal arteries; these break up into a rich network of capillaries in all parts of the gland. The nerve supply of the bladder is also derived from two sources, its first part being supplied by a branch of antennary nerves (coming from the supra-oesophageal ganglion), its hinder part by a nerve from the infra-oesophageal ganglion. No nerves were observed in the gland itself.

Action of the Heart of the Crayfish.—M. Felix Plateau, of Ghent, has succeeded in applying the graphic method to the study of the heart's action in the crayfish. A curve is obtained, of which the ascending portions correspond to diastole, and the descending to systole, contrary to what obtains in the Vertebrate heart. It is strikingly like the trace of the contraction of a muscle; a rapid, almost sudden ascent, with a short flat summit, then a gradual descent, at first quicker, then slower. This, however, does not represent the whole truth; it is possible also to demonstrate a wave affecting the muscular wall of the heart, and travelling from behind forwards, thus demonstrating that this condensed heart is a true dorsal vessel. On the stimulus of the entrance of renovated blood, it is only the hinder half or two-thirds of the heart that contracts immediately. This forces blood into the forward half, which contracts only when the posterior division is again dilating. When the temperature is increased, as a general rule the diastolic phase is abbreviated, the number of pulsations rising at the same time. M. Plateau has also succeeded in making experiments on the action of the cardiac nerve of Lemoine, an unpaired branch of the stomatogastric ganglion. It

is proved that excitation of this nerve quickens the pulsations of the heart and augments their energy, while section of it slows the heart. Excitation of the thoracic ganglia always retards the heart, the converse of the cardiac nerve. Acetic acid applied to the heart substance arouses its contractions even when they have ceased, and maintains them for several hours.

The action of a number of other substances is equally noteworthy, and M. Plateau's full communications to the Académie Royale of Belgium will be awaited with interest by physiologists.*

Natural Classification of the Spiders.—Dr. Bertkau points out † the great difficulty of classifying the group; comparing them with the Insecta (Hexapoda), he says that the body is only divided into two regions, that there are no antennæ or wings to aid in discrimination, and that even those parts, which vary in other Arthropoda, present in them a remarkable uniformity; thus there are almost always eight eyes, and a variation in the number of these is of doubtful value, the mouth-organs are always of the same structure, and the number of joints in the legs is very fairly constant; nor do the spinning warts afford any greater aid. Turning to the variations in their habits, he observes that Aristotle, just as much as the latest systematists, drew attention to the difference in the characters of the web, and of the methods by which these creatures obtain their prey, but these differences are of no value as aids to classification from a morphological point of view.

In the present essay an attempt is made to take into account all the variations in organization, and to use only the characters of the web as a last resource, for the very excellent reason that these are of no assistance in the classification of dead Spiders. The following is a short outline of the grouping here proposed:—

Sub-order I.—*Tetrasticta*; two pairs of stigmata on the lower surface of the abdomen; ovaries and testes circular, the entrance to the seminal pouches simple, and just in front of the orifice of the oviduct.

i. *Atypidæ*; with eight eyes, all four stigmata leading to the “lungs”; six spinning warts, the anterior pair short, and consisting of one joint; mandibles horizontal in direction; more than one receptaculum seminis.

ii. *Dysderidæ*; with six eyes, the two hinder stigmata leading into a tracheal system; the six spinning warts sub-equal, and all consisting of one joint each; mandibles vertical, or directed obliquely forwards; only one receptaculum seminis.

II. *Tristicta*.—Only one pair of stigmata on the lower surface of the abdomen; ovaries and testes in two branches; there are ordinarily two openings into the seminal pouches.

These are divided into nineteen families, many of which have well-known names, though their limits are in most cases revised; their relations to one another are exhibited in a genealogical tree.

The author considers that the *Tetrasticta* are the more primitive

* ‘Nature,’ xix. (1879) 470.

† ‘Arch. für Naturgeschichte,’ xlv. (1878) 351.

forms, basing this chiefly on the presence of two pairs of stigmata, and the simplicity of the male copulatory organs; palæontology, however, affords some support to his views, inasmuch as *Protolycosa* belongs to this group. With regard to this fossil form, Bertkau suggests that the backwardly directed spinous processes found on the right side represent the hinder pair of spinning warts, and that the small spines on them are the spinning tubes.

Researches into the Developmental History of the Spiders.—The indefatigable Barrois has a preliminary chapter on this subject in M. Robin's Journal.* The chief aim of the author was to examine the arrangement of the germinal layers, and the mode of development of the internal organs; this work, which has never yet been undertaken, was effected by the aid of fresh ova, and of sections stained by bichromate of potash and osmic acid. Passing by some remarks on the relative value of the observations of Balbiani and of Ludwig, in which attention is drawn to the highly granular character of the protoplasm of the formative layer, we note that Barrois adds something to the observations made by Claparède on the primitive streak; the latter admirable student had noted the appearance of thoracic, abdominal, and post-abdominal zonites, but he did not note the presence of two cords, formed of several rows of embryonic cells; to these Barrois gives the name of *germinal bands*; they are derived from a primitively continuous mesodermal layer, and are found throughout the whole length of the body, although they are largest in the thoracic region; in this they may be seen to be dividing into a median (nervous) and a peripheral portion; more anteriorly, they form the cerebral lobes (procephalic lobes of Claparède and Huxley); on the whole this region is, at this period, strikingly like the same parts in the Scorpions, the development of which have been already described by Metschnikoff. Behind the thoracic region there are ordinarily ten zonites, of which the first four are provided with the rudiments of appendages.

By following out the stages of development step by step, Barrois has been enabled to discover a stage—to which he applies the term *Limuloid*—which was not observed by Claparède. In this state the embryo has an exceedingly remarkable appearance; it is divided into two distinct parts, thoracic and abdominal; the posterior portion is formed by the fusion of all the tergal arcs, in which, however, it is possible to observe a pre-abdomen, consisting of six, and a post-abdomen, consisting of four segments. Of the former series four are larger than the other two, and are seen to be provided with appendages; the anal segment, if examined from its ventral surface, is found to be made up of three segments, so that there are altogether twelve segments in the abdomen, or six in the post-abdomen, and the number of these in the Spiders is found to correspond with those of the same region in the Scorpions. In one of the Xiphosura, *Hemiaspis limuloides*, the arrangement of parts is strikingly similar to what is here observed in the embryo of the Spider; the higher development of

* 'Journ. Anat. Phys.,' xiv. (1878) 527.

the first four abdominal segments appears to be a constant phenomenon in the Arachnida; in explanation of this it may be observed that these segments appear together and before those that succeed them, and that the same remark applies to the ganglia that innervate them. The vitelline portions of the egg are also of great interest; the "vitelline vesicle" forms a sac on the ventral surface, just as in Fishes, and as in them it owes its existence to the presence of too much yolk; Barrois believes that attention is now for the first time drawn to the presence of this body in any Invertebrate. The succeeding stages are too briefly indicated for us to be able to give any shorter account of them; there are a number of figures in illustration.

New Genus of the Cheliferidæ.—M. E. Simon has found* that many of the forms of this group which came to hand are not indigenous to the French fauna; the one now to be mentioned was found in a chest containing some Japanese objects, and is eliminated by M. Simon from the "*Arachnides de France*," of which he is preparing a monograph. The name *Lophochernes (bicarinatus)* is given to it; it has most of the characters of *Chelifer*, but the second cephalothoracic groove is much deeper than the first; the first five abdominal segments are strongly carinated at the sides, which is not the case with those that succeed them. The movable portion of the chelæ is strongly curved, and only touches the fixed part by its tip when the pincer is closed.

New Acarina.—Dr. Kramer points out† that the observation of Claparède as to the enormous number of these forms is confirmed by every new series of observations; these forms are moreover most remarkable, while they never lose the characters common to their family; the divergencies seen in them cannot be explained as due to different habits of existence, and as yet comparative embryology has been able to throw but little light on the question. The true naturalist must, therefore, content himself for the present by bringing together the material which shall aid later observers in giving a more general review of the group. With this object in view he proceeds to deal with some new forms; two new genera, *Labidostoma* and *Gustavia*, and six species of already known genera are described.

Organization of Myriapoda.—The Myriapoda collected in Turkestan by Fedtschenko have been examined by N. Sograff of Moscow, who gives in the '*Zoologischer Anzeiger*' a preliminary account of the chief results he has obtained.‡

1. On the under side of the head of *Chilopoda* occur a quantity of chitinous plates, which are not of a segmental nature, but are mere cuticular thickenings (sclerites) serving for the attachment of muscles.

2. The alimentary canal is lined with very peculiar epithelial cells of two kinds; the first are long and fine, and bear more resemblance to the olfactory cells of Vertebrates than to the cells usually found in the gut of Arthropods; the second kind are oval or rounded,

* '*Bull. Soc. Zool. de France*,' iii. (1878) 66.

† '*Arch. für Naturgeschichte*,' xlv. (1879) 1.

‡ '*Zool. Anzeiger*,' ii. (1879) 16.

and contain brown granules: the rectum is also lined with a characteristic epithelium.

3. The circulatory system consists of a very narrow dorsal vessel, the walls of which are composed of annular striated muscles; the alary muscles appear to exist only in *Scolopendra*.

4. The tracheæ agree in their disposition and external appearance with those of the larvæ of insects (Lepidoptera), the stigmata are provided with a simple but very characteristic valvular apparatus.

5. The brain consists of fibres, and of cells of two kinds. The fibres have a reticulated arrangement in the interior; the cells of the first kind are large, and uni-, bi-, or tripolar: those of the second kind are much smaller, round or elliptical, and correspond to the cerebral granules (Hirnkernen) of Dietl. The form of the brain is correlated with the number of eyes and with the length of the body; the longer the body of the Chilopod, the fewer are its eyes, and the smaller its optic lobes. The latter are wholly absent in the *Himantaria*.

6. The structure of the eye resembles that of insect larvæ. The eyes of the *Lithobii* and *Scolopendræ* are quite like those of the larva of *Acilius*, &c., or those of Spiders. The compound eye of *Cermatia* consists of a number of lesser eyes, closely resembling those of the larvæ of *Hymenoptera*. The optic lobes terminate in a small nerve, the branches of which go to the separate eyes.

7. The genital organs are very peculiar with regard both to their external and internal structure. The ovary agrees closely in structure with that of *Arachnida*. The eggs are disposed in grape-like bunches, the ripe ones being covered with a layer of cells, probably epithelial. The receptacula seminis exhibit epithelial and muscular layers. The testis is filled with large quadrangular mother-cells with large nuclei, probably derived from the epithelium of the thin upper part of the gland. Its walls are invested with strong muscular bundles and a layer of nuclei. The walls of the vesicula seminalis consist of an epithelial layer and of a delicate network of muscles.

8. Glands occur in great numbers in the mouth, in the thorax, on the outer surface of the body, and on the appendages. The pores on the coxæ (Coxalporen) are also glandular. The duct of the poison gland is a strong chitinous canal with small tubules of the same material opening into it; each of these tubules terminates in a pear-shaped gland-lobule. The whole gland-system is covered with a characteristic layer of muscular fibres: so also is the nervous system.

9. The organization of the short Chilopods with comparatively few legs (*Lithobius*, *Cermatia*, *Scolopendra*) is higher than that of the long *Geophili* and *Himantaria*.

10. Of the other *Arthropoda* the *Chilopoda* are most nearly related to the larvæ of *Lepidoptera*, *Hymenoptera*, and *Coleoptera*.

Polyxenus lagurus, De Geer.—Haller makes some remarks* on this curious little Myriapod, which he got from under the bark of old cherry-trees, though never in brushwood or hedges; he draws attention to the structures found in the caudal appendages of these animals, and

* 'Arch. für Naturgeschichte,' xliv. (1878) 91.

points out how closely they resemble in form the siliceous spicules of various Sponges. He has observed how greatly these are in the power of the small spiders that live with them, and which are able to paralyze their action although not able to destroy them.

Parthenogenesis in Bees.—MM. Perez and Sanson have each an article in the last number of the 'Annales des Sciences Naturelles' (Zool.),* in which they repeat and confirm the views already expressed on this subject. See p. 88 of this Journal.

Spinning Glands of the Silkworm.—Each of the two spinning glands Professor Lidth de Jeude describes† as consisting of three parts; a thin-walled efferent duct, a thick and slightly coiled reservoir, and a long and greatly coiled hinder portion. In all three it is possible to make out a thin and homogeneous *membrana propria*, and a unicellular layer of pavement-epithelium; at the commencement of the median portion of the glandular region there is also a firm cuticular *intima*. The *tunica propria* is traversed by tracheal ramules in the median and hinder portion of the gland, and numerous branches of these pass into and between the epithelial cells; each of these cells contains several twigs. The cells of the glandular epithelium differ in character in each of the three regions, but they all agree in displaying the absence of a distinct membrane, the presence of large stellate nuclei, and a colourless protoplasm. The largest and flattest cells are found in the median, and the smallest in the anterior part.

With regard to the efferent duct, it is noted that the protoplasm of its cells consists of closely approximated doubly-refracting fibrillæ set in a singly refracting substance; they are placed at right angles to the axis of the canal and give the micro-chemical reactions of albumen. The protoplasm is separated from the *intima* by a transparent, singly refracting layer, which is traversed by pore-canal; this layer is easily broken up by treatment with alkaline reagents.

The *intima*, which is about $\frac{1}{1000}$ mm. thick, is of a yellowish-brown colour, is very firm, elastic, and doubly refracting; it is fibrous in structure, but the fibres are not destroyed by alkalis. The lumen of the efferent duct is filled by a colourless fluid, and the filaments found in it are highly refracting and are anisotropic. The protoplasm of the cells of the median portion is finely granular, and is not anisotropic; it differs in character in different regions; the fibres which are found at the periphery of the tube are also essentially protoplasmic in character, and are not chitinized. The very wide portion of the median region is in the posterior portion completely filled by the highly refractive and viscid secretion which is found in it, and which goes to form the silk-threads.

The cellular protoplasm of the hinder portion of the gland is granular, and consists of irregularly prismatic bodies; the cell-substance is, when dried, highly refractive.

The following are the more important physiological results recorded by the author: When living glands were electrically irritated,

* Vol. vii. (1879).

† 'Zool. Anzeiger,' i. (1878) 100.

the contents of the glands were expelled with greater rapidity; tetanization had a more marked effect, and produced changes in the characters of the cells; the most important of the chemical elements found in the fully formed silk-thread was fibrous; the yellow colouring matter was observed to be formed in the cells of the median portion, and it was also noted that the silk-threads did not exhibit their special characters, or power of refracting light, unless they were taken from the region in which the two efferent ducts were found united.

Odoriferous Cells in Lepidoptera.—The observations of Fritz Müller on the attractive properties possessed by the males of certain Lepidoptera revealed the presence of certain cells which seemed to give off an odorous oil of the ether series; the scaly cells to which this oil owed its existence were never, however, found on the *costæ*, where, as it was imagined, the living cells of the wings were alone found. Dr. August Weissmann now* points out that this last supposition is erroneous, and that the other cells of the wing form a connected network of irregularly-branched stellate cells, which are placed in more or less closely set transverse rows below the scales, though they can only be made out by the use of reagents.

The scale itself is capilliform, and traversed by a single axial canal, which opens freely at the tip (as in *Papilis protesilaus*), or there are a number of canals, which open on to the surface of the scale. It is in the butterflies of Brazil or the Tropics that the odoriferous cells are best developed, although indeed in *Pieris napi* it is quite easy to convince oneself that the odour is given off from the scales, by passing the finger over the wing; the finger will be found to retain a strong odour, not unlike that of citrons. In the closely allied species, *P. rapæ*, the same may be observed, but in it the odour is less strong and of a different character.

In connection with these observations of Weissmann, we may draw attention to the communication which Fritz Müller has made to his brother Hermann;† he says that he finds his nose gets sharper in detecting odours from butterflies; thus, the male of *Callidryas trite* was two years ago odourless, but he is now easily able to detect its odour. In the male of *Didonis biblis* he has now observed three distinct odours in different parts. The females of *Callidryas* have highly odorous glands connected with their generative organs, which give off an acetous scent; while the males of the same form have a musk-like odour from the same parts.

Seasonal Dimorphism of Lepidoptera.—Dr. Kramer makes some elaborate computations‡ as to the modes by which this dimorphism, the phenomena of which have been so learnedly treated by Professor Weissmann, have been evolved; a severely mathematical study leads him to the following conclusions:—

1. By the cumulative action of *transmission* (heredity) a large

* 'Zool. Anzeiger,' i. (1878) 98.

† Ibid., 32.

‡ 'Arch. für Naturgeschichte,' xliv. (1878) 411.

number of animal groups have been derived from the same species, and exhibit various grades of variation.

2. Those groups which are most and those which are least altered are the less numerous, while those which have undergone the mean amount of variation are the most numerous.

3. The series of variations is an unbroken one.

4. These variations are not affected by any length of time.

Development of Podurella.—There is a short note in the ‘Revue Internationale des Sciences,’ vol. ii. p. 439, on the investigations of Barrois. In the anterior region the sternal ares are found to be, as in other insects, the first formed, and to be developed from below upwards; the cephalic lobes, the antennæ, and the labrum can soon be made out in the cephalic region; then follows the mouth, then six pairs of limbs, of which the first three go to form the labrum and the mouth-organs, while the other three develop into the thoracic limbs.

In the abdominal region, it is very different; the tergal ares are the first to be formed, and development takes place in a dorso-ventral direction; in this stage the insect is said to have no slight resemblance to the *Zoëa* form of the Crustacea.

Respiratory Organs of the Larva of Culex.—These are seen by Dr. G. Haller* to be excellent examples of an intermediate stage between the arrangements found in the larvæ of the Phryganida and of the Ephemerida on the one hand, and in such adult forms as *Nepa* or *Ranatra* on the other.

Two well-developed longitudinal trunks extend through the whole body, and supply all its parts with air; they are extremely delicate, and are provided with a fine spiral band of chitin; just before reaching the cephalic segment they turn inwards at a right angle; at this point there is developed a contractile vesicle, to which the older observers gave the epithet “respiratory”; examination of its structure reveals, however, its essentially glandular character, and proves that it is connected with a cellular cord placed in the cephalic region. So far as is known, these creatures are not provided with any salivary glands, but the organ in question greatly resembles one. In the terminal segment of the body the tubes pass towards the middle line, and form respiratory tubes, placed one above the other; the author distinctly affirms that they do not unite, and that they even open separately; above these openings there are three sharp, projecting, points, which are capable of being closed, and of thus forming a kind of valvular projection against the entrance of water or other fluids. So long as the animal remains at the surface, these tubes are freely open to the atmosphere; but when it is forced to descend into the water, the tracheal gills, now to be described, come into function. These gills have the form of delicate elongated lamellæ, in which the terminal branches of the trachææ are found to ramify; they are placed on the opposite surface of the body to the respiratory tubes, and are provided with long branched hairs, of which there are generally eleven.

Where the branches that supply the tracheal gills are connected with the longitudinal and primary air-vessels, an air-reservoir is deve-

* ‘Arch. für Naturgeschichte,’ xliv. (1878) 91.

loped; these consist of one or more tufts of a large number of short ramules; their function appears to be to supply the organism with air during such short periods as those in which respiration is prevented or retarded; the hairs are better developed on the side nearer to the respiratory tubes than on the other. Very much the same relation of parts is found to obtain in the pupa.

In the imago the conditions appear to be altogether different; the insect now respire by the aid of stigmata. The hairs on these structures are described in some detail, and the descriptions illustrated.

Sucking Plate of *Dytiscus*.—The same author describes* the chitinous organs on the sucking plate on the first pair of feet in the males of *Dytiscus*. These, which appear to be of aid in copulation, are formed by the differentiation of the first joints; in copulation they are applied to a shallow groove on the thorax of the female; they are cordiform in shape, and are formed from three of the joints of the tarsus; in colour they are more or less red or brown, and on their upper surface they present a roughened, file-like surface, which is produced by the presence of a number of rounded, flattened organs, some of which may be easily perceived by the naked eye. In some, the structure is remarkable on account of the presence of radiating, yellowish, and branching chitinous hairs, separated by a colourless transparent membrane, which is more or less distinctly striated; on the inner surface of these organs there are rounded bodies which produce a dark brown secretion, the function of which appears to be to protect the bodies in question against the action of water. In others there are several transverse rows of smaller bodies; these consist of a single hollow chitinous hair, which is closed at its tip; this again is provided with a transparent chitinous membrane of a brownish hue. Adding together all the prehensile structures observed on these appendages, the author comes to the conclusion that there are no less than four hundred of them, the power of which is at once apparent. The plates now described are provided with a number of hairs of two kinds; in one they are long, firm, blunt, and curved a little inwards, so as to afford a protection for the subjacent structures; the others are broad and short, are distinctly striated in a longitudinal direction, and are inserted into strong chitinous rings.

Development of Polyzoa.—M. W. Repiachoff, of Odessa, has studied the development of *Tendra zostericola*,† of *Lepralia pallasiana*, and of two species of *Bowerbankia*.‡ In *Tendra* complete yolk-division takes place, and an equal-celled mulberry-mass (archimorula) is produced, which soon becomes hollow by the formation of a cleavage cavity, producing a one-layered archiblastula. Four cells lying together in the centre of the ventral side, then enlarge greatly, and undergo extensive division, forming a mass of cells projecting into the cleavage cavity. This mass is the endoderm; its cells soon separate from one another, forming a cavity, the archenteron, which is

* 'Arch. f. Naturgeschichte,' xliv. (1878) 91.

† 'Zeitsch. f. wiss. Zool.,' vol. xxx. Suppl. (1878) 411.

‡ 'Zool. Anzeiger,' i. (1878).

at first quite closed, but afterwards opens on the exterior by a blastopore, produced by the separation of those endodermal cells which occupy the position of the four cells originally invaginated, on the ventral surface of the embryo. At a still later stage the blastopore thus formed closes up, both mouth and anus being subsequently formed as invaginations of the ectoderm.

The chief fact about *Lepralia* is the confirmation of the author's previously expressed opinion that the structure called "stomach" by Barrois is really a sucker.

The two *Bowerbankia*-larvæ were pear-shaped, with a mantle covering the dorsal and ventral surfaces, and a mantle-cavity opening by an aperture at the small end of the embryo. The larger specimen had on its flattened ventral side an elongated ciliated aperture, in relation with which, in the interior of the body, was a granular mass representing the endoderm. On the ventral side of both was a longitudinal groove, bounded by two folds, and resembling the medullary groove of a Vertebrate. In the smaller specimen this was continuous along the whole ventral side; in the larger it was interrupted by the ciliated aperture just mentioned.

In both larvæ there was a shallow annular constriction round the middle of the body, and, at the same place, a thickening of the mantle. A second constriction, with a corresponding thickening of the mantle, occurred between the first, and the thin end of the body. Corresponding to these constrictions, there was, in the smaller larva, a weak indication of segmentation of the ventral (supposed medullary) folds.

The early stages of development in the *Ctenostomata* (the group to which *Bowerbankia* belongs) resemble in a general way those of *Tendra*, but the gastrula approaches more nearly to the simple archi-gastrula.

In a further communication Repiachoff* has studied more carefully the later developmental stages of *Tendra*, of which only a brief account was given in his former paper. He states that he has proved the sucker of the embryo ("stomach," Barrois) to originate as a thickening of the ectoderm on the ventral side of the body. He also describes the blind endodermal sac or midgut of the embryo as extending uninterruptedly quite to the upper end of the body; above, therefore, the involution which becomes the foregut. Subsequently this upper portion of the endoderm becomes separated from the remainder, and forms a mere accumulation of cells in close proximity to the oral furrow. The remainder of the endodermal sac fuses with the foregut involution, and forms with it a semi-lunar alimentary canal.

Presence of a Segmental Organ in the Endoproct Polyzoa.—In October, 1877, Hatschek of Prague discovered in *Pedicellina echinata*, both in the larval and adult state, a vibratile canal which he apparently could not quite make out, and which he compared to the vibratile organs of the Rotatoria. M. L. Joliet has confirmed †

* 'Zool. Anzeiger,' ii. (1879) 68.

† 'Comptes Rendus,' lxxxviii. (1879).

these observations, and extended them to the whole group of Endoproct Polyzoa.

In some *Pedicellinae* which he observed the vibratile organ was double, and situated in the cavity of the body in the space comprised between the cesophagus, the stomach, and the matrix. It was composed of a short tube, ciliated on the interior surface (swollen in the middle), which on the one hand opened into the matrix not far from its external orifice, and on the other opened obliquely into the cavity of the body, by a mouth slightly bell-shaped and furnished with active vibratile cilia.

This organ, provided with a vibratile mouth, and placing the cavity of the body in communication with the exterior, has all the characters of a segmental organ. It appears very early in the bud. When the stomach is only outlined, and before the tentacles appear, a ciliary movement is seen at the place which it subsequently occupies.

M. Joliet observed the same organ in a second species of *Pedicellina*, and in *Loxosoma*, and he considers that in the Endoproct Polyzoa may be regarded as constant the presence of an organ widely distributed in the worms. In face of the attempts which have been made in later years to bring the Polyzoa and the Annelida together, it seems to him useful to put forward his observations.

Power of Locomotion in the Tunicata.—Mr. W. Macleay, F.L.S., has observed,* with some astonishment, that large Ascidians which he found strewn at low water on a sandy beach after a storm, are or seem to be capable of a certain amount of locomotion—they do change their positions most undoubtedly; in doing so they leave upon the wet sand a distinct track in accordance with the weight and size of the mass, and these movements are not in any way attributable to winds or waves. He at first thought it possible that the movements might be due to the agency of some of the animals adhering to the outside of the mass, but he found that the only organic attachments, excepting a few small shells, were clusters of simple Ascidians utterly incapable, therefore, of combined action, and much too small for their individual efforts to produce any effect.

Notwithstanding, however, this apparently convincing evidence, he is indisposed to believe it possible that an animal so completely shut up in a thick coriaceous unmuscular sac, can have any power of external movement, nor is it likely that such a power would be possessed by an animal whose whole life (except in infancy) has to be passed firmly rooted to the bottom of the sea, and he hopes that some one having the leisure and opportunity will endeavour to solve this problem.

Extension of the coiled Arms in Rhynchonella.—Years ago Von Buch recorded that Otto Frederic Müller had observed the Brachiopod *Rhynchonella psittacea* protrude its arms beyond the anterior borders of the shell. This single observation was not widely accepted, and many doubted the possibility of the arms being exerted in this

* 'Proc. Linn. Soc. N. S. Wales,' iii. (1878) 55.

manner. In the year 1872, while studying living *Rhynchonella* in the St. Lawrence, Mr. E. S. Morse observed * a specimen protrude its arms to a distance of four centimetres beyond the anterior borders of the shell, a distance nearly equalling twice the length of the shell. This year he again had an opportunity of studying it in Hakodate, Yesso, and again observed the same features. Specimens lying on the bottom of a glass dish protruded their arms a short distance, and remained in this position for hours. The movements of the arms were very sluggish, though the cirri were constantly in motion. Sometimes the shells closed upon the arms before they were retracted. *Lingula* has the power of partially protruding its arms, as he has repeatedly observed in North Carolina and Japanese species. *Terebratulina* can also partially protrude the cirri.

Eye of the Lamellibranchiata.—It is peculiarly interesting to observe that the “visual purple” which the researches of Franz Boll and Kühne have made known to all microscopists is to be observed in the eyes of some of the Invertebrata; Professor Hensen calls attention to this matter † in reference to certain observations made by Krukenberg on the eyes of the *Cephalopoda*. Hensen has observed in *Pecten Jacobæus*, that the layer of rods is distinguished from the surrounding parts by its coloration. Krukenberg in his notice concludes that in the *Cephalopoda* the colour is persistent, but in *Pecten* Hensen noted its rapid disappearance. Hensen also corrects some of his observations on the eye of this Lamellibranch, which were published a few years ago.

Foot of the Unionidæ.—J. Carrière has been making some observations ‡ on the foot of the *Unionidæ*, which have led him to the following conclusions: the injections of the lacunæ and blood-vessels, which one is, at times, able to make through a cleft at the margin of the foot, are effected by the destruction of fine tissues; this cleft does not, that is, communicate with the vascular system, but is the aperture of a closed, and variously developed gland. This organ often contains a yellow secretion. The various stages of its development are indicated, and it is pointed out that it is greatly reduced in *Unio*, where indeed it may be merely represented by a short ciliated canal. It is concluded that it represents a rudimentary byssus gland, and the author promises more complete details.

“Digger” Mollusc and its Parasites.—The little digger, *Donax fossor*, represents a countless mass of life off Cape May, New Jersey, large areas looking like barley grains lying on a malting floor when the tide retires. It gets uncovered by the breaking surf and instantly reburies itself with its powerful foot when the waves retire. The siphons are long and active, looking like so many wriggling worms. Although the prey of shore birds and fishes, and beset with parasites, they lie so thick as even to interfere with one another in burying themselves. The liver of these bivalves is always found

* ‘Am. Jour. Sci. and Arts,’ xvii. (1879) 257.

† ‘Zool. Anzeiger,’ i. 30.

‡ Ibid. (1878) 55.

beset by flukes, from half-a-dozen to several dozen, and a bell-shaped trichodina crowds the branchial cavity.*

Hermaphroditism in, and the Spermatophores of the Nephropneustous Gasteropoda.—Dr. Pfeffer describes† the arrangement of the generative organs of some of the *Nanidina* in the Berlin Museum; the genus *Trochanina* is founded on external characters, but the examination of the internal parts has brought to light variations in structure, which should lead to the breaking up of the genus. The forms which compose it are distinguished by having an accessory gland to the penis and by the absence of the retractor muscle of this organ; in *T. Schmelziana* and *T. radians* the seminal duct is connected with the lower portion of the penis by well-developed connective tissue, but in the other species it is connected by a muscle with the uppermost parts of the uterus. In some still more divergent forms there is a duct connecting the prostate with the stalk of the vesicle.

The arrangements in *T. ibuensis* are such as to make copulation impossible, as the penis has no efferent duct, and the sole orifice is that which belongs to the oviduct; the presence, however, of the just-mentioned duct atones for this structural defect, or, in other words, renders the penis unnecessary. In *T. percarinata* the duct was likewise present, and no orifice could be detected in the penial papilla. In the other forms there are no apparent arrangements for self-impregnation, though there are difficulties, such as for example the absence of a retractor penis, set in the way of reproduction by copulation.

The spermatophores were found in the penis, or in the bladder, and there might be, in different species, one, two, or even three of these bodies, with fragments of others. They exhibit in most cases the same general characters; they form a sausage-shaped body invested in a thin, white, horny covering, provided at one end with a spine-shaped projection, and continued at the other into a thinner, long, dark brown tube; this tube becomes semicircular towards its free end and terminates in an enlargement, which is provided with one or two crowns of spines. When acted upon by water, the contents swell towards this end; they are then seen to contain a number of hyaline chitinous fibres, and some oval or lancet-shaped calcareous corpuscles, such as are generally, if not always, found in the penis of the *Zonitidae*. The spermatophores are, it is concluded, developed in the flagellum of the penis, or through the whole extent of this organ; and, from the complexity of their structure, it is thought to be unlikely that there is a second formation of spermatophores during the same copulation period.

Mucous Threads of Limax.—Dr. Eimer, having described‡ the habits of *Limax agrestis*, and having observed that he was unable to find any reference to their powers of producing mucous threads, induced Professor Martens to make some remarks on the subject, § of which it may be interesting to give a short account.

* 'Nature,' xix. (1879) 470.

† 'Arch. für Naturgeschichte,' xlv. (1878) 420.

‡ 'Zool. Anzeiger,' i. (1878) 123. § Ibid. 249.

Martin Lister, two hundred years ago, noted the production of filaments 2 feet long; Shaw, in 1776, observed filaments 8 feet from the ground, and Hoy, in 1789, gave an account of them to the Linnean Society. For many years these and similar observations seem to have been well known, but since the time of Woodward, Johnston, and Moquin-Tandon, no information is given in the more popular manuals. Professor Martens notes as a curious fact that the majority of observations on the habits of *Limax* has been made in Great Britain, and, though making full allowance for the superior advantages of our damp climate, thinks that the fact is due to the better instruction and greater interest of our naturalists. He observes, that the power of producing these threads is not confined to *Limax*, but that *Megalomastoma suspensum* in the West Indies, and *Potamides obtosus* on the coasts of Borneo, have been observed to have it also; and, noting the striking resemblance between these, and the byssus-threads, concludes by observing that there are marine Gasteropoda capable of producing similar filaments.

BOTANY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE PHANEROGAMIA.

Development of the Embryonal Sac.—The following are the summarized results of M. J. Vesque's researches on this subject.*

1st. In Angiosperms, the embryonal sac of Brongniart is not composed, as in Gymnosperms, of a single cell; on the contrary, it results from the fusion of at least two cells superposed and at first separated by septa.

2nd. The cells which are destined later on to compose the embryonal sac, all proceed from one and the same primordial parent-cell. M. Warming, who discovered them, rightly gives them the name of special parent-cells, comparing them to the parent-cells of pollen or of spores. This comparison is justified by the physical characters of the septa.

3rd. When the development of the special parent-cells is completed, each gives rise to four vesicles homologous to the four pollen grains which originate in one and the same parent-cell.

4th. The variations to be observed in the different types of Angiosperms depend on the more or less early arrest of development which happens to the special parent-cells.

5th. The first cell always produces the sexual apparatus. It blends with the second cell, in order to constitute the major part of the embryonal sac. When the second cell has produced its four vesicles, the eight free vesicles of the embryonal sac behave in the manner described by Strasburger in the cases of *Orchis* and *Monotropa*. This fact is observed in certain Monocotyledons and apetalous Dicotyledons.

6th. The other special parent-cells (the third, fourth, and fifth) may produce the four vesicles. Each of the vesicles is homologous with the pollen grain, and it is convenient to retain for it the name of *antipodal vesicle*. When these parent-cells persist in their primi-

* 'Ann. des Sci. Nat. (Bot.),' xi. (1878) 276.

tive state without producing vesicles, they themselves simulate superposed, not juxtaposed, antipodal vesicles. These differ from the former in a morphological point of view, and M. Vesque gives them the name of *anticlinal cells*.

This state has been observed in several Monocotyledons, certain apopetalous Dicotyledons, and in almost all the Gamopetalæ.

7th. The second cell appears to be the first to undergo an arrest of development. In this case its vesicle directly becomes the proper vesicle of the embryonal sac, and this cell does not produce any antipodal vesicle. This fact, observed in some Monocotyledons and Apopetalæ, becomes the rule in the Gamopetalæ, which are from this point of view the farthest removed from Cryptogams.

8th. In the Gamopetalæ (with some very rare exceptions) the first cell alone produces a complete or incomplete tetrad, which is nothing but the sexual apparatus composed of two, three, or four vesicles. The second cell seems to take upon itself the vegetative rôle of the embryonal sac. Its undivided vesicle becomes the vesicle of the embryonal sac.

The cells 3, 4, 5 (or 3, or 3 and 4, according to the number of the special parent-cells) are anticlinal vesicles, or produce antipodal vesicles by dividing their vesicles.

9th. In the greater number of Gamopetalæ, the formation of the endosperm is connected with the ulterior development, by division, of one or many of the special parent-cells. These latter being homologous with the parent-cells of spores, it is permissible to consider the endosperm of these plants as a sterile female prothallus.

Protein-crystalloids.—Dr. A. F. W. Schimper, son of the well-known bryologist, has recently published a treatise on this subject.* He finds the crystalloids contained in seeds, to which he has paid most attention, to belong mostly to two systems; some are hexagonal-rhombohedral-hemihedral; while others are regular tetrahedral-hemihedral; the former again being divisible into three species. Their crystallographic properties agree with those of true crystals, except that, as Nägeli has already pointed out, their angles are somewhat less constant. Regular crystalloids swell up in water equally in all directions, and therefore undergo no change in form; the swelling of hexagonal crystalloids is, on the other hand, accompanied by certain changes both of form and of optical properties. Crystalloids are, however, perfectly distinct from true crystals; the same substance never occurs both as crystalloid and crystal.

Composition of Chlorophyll.—Some further researches on this subject are recorded by Professor Dippel.† He starts with the observation that neither of the substances into which Kraus divided crude chlorophyll, xanthophyll and cyanophyll, are themselves simple substances. Xanthophyll, which is not entirely free from fluorescence, and which is certainly not a product of decomposition due to the presence of water in the alcohol employed, is, according to circumstances, coloured of a more or less distinct blue by acids, and this

* 'Botanische Zeitung,' xxxvii. (1879) 45. † 'Flora,' xxxvi. (1878) 17.

blue fluid can be decomposed, by agitation with benzin, into a yellow and a blue constituent. Cyanophyll can also, like crude chlorophyll, be decomposed, both by agitation and by treatment with potash and alcohol, into a yellow and a green constituent. From an alcoholic solution of crude chlorophyll or from cyanophyll there can, however, be obtained, by treatment with potash and ordinary benzin, a pure yellow substance called by Kraus *xanthin*, in which there is no trace of fluorescence, which is not coloured blue by acids, and which is also recognized by presenting three clearly defined absorption-bands in the more highly refrangible, and a weak band (?) in the less refrangible part of the spectrum. If the potash is precipitated from the alkaline-alcoholic solution which is obtained in the production of xanthin, by means of very dilute sulphuric acid, a beautiful green or bluish-green alcoholic solution is obtained, in which the green constituent of chlorophyll is contained, termed by Kraus *chlorin*. This solution, which resembles chlorophyll in its colour, its fluorescence, and in its property of being turned blue by acids, must be considered rather as a mixture than as a product of decomposition. The yellow colouring matter of leaves and of golden yellow petals, which is soluble in alcohol, presents precisely the same spectroscopic phenomena as the yellow ingredient of chlorophyll obtained by shaking with benzin. From the absorption phenomena of the crude alcoholic extract of the petals of *Eschscholtzia californica*, it is evident that we have a mixture of two constituents, one reddish yellow and soluble in water and alcohol, the other golden yellow, and soluble in alcohol, but not in water. The results are the same with the yellow colouring matter of the petals of *Hemerocallis fulva* and *Dumortieri*, and the ligulate petals of the marigold; and it seems not improbable that the absorption phenomena of other more or less strongly coloured orange petals and coatings to the fruit, such as those of *Berberis Darwinii* and *Euonymus europæus*, are due to similar causes.

B. CRYPTOGAMIA.

Action of Light and Heat on Swarmspores (Zoospores).—In opposition to the observation of many botanists that swarmspores in water group themselves in a determinate way under the influence of light, Sachs has shown by experiment that in emulsions consisting of oil and a mixture of alcohol and water, the fine oil drops also show similar groupings, and that these are caused by currents in the fluid produced by differences of temperature.

All that had been published on the subject was reconcilable with these results, but a statement of Dodel-Port on the behaviour of the swarmspores of *Ulothrix* clashed with this explanation. According to him, the spores in the vessels collected on the side next the window, which, as the experiment was made in winter, was the colder side, while on the other side they flowed towards a lighted petroleum lamp, and consequently to the warmest side. Strasburger then took up the subject, and submitted it to a thorough experimental examination, the results of which are published in the 'Jenaische Zeitschrift für Naturwissenschaften.' *

* Vol. xii. 551.

Strasburger first repeated most of the experiments of Sachs, both with emulsions and with swarmspores, and found the same results in every case. But besides these passive groupings of the swarmspores caused by currents, he observed some that were caused by active movements on their part. These were examined, not in large vessels, but in drops which, hanging from the covering glass in a moist chamber,* could be examined under the Microscope.

The experiments were carried further by applying light of different colours, either by passing it through different coloured solutions before it reached the drops, or by directing the different parts of an objective spectrum on the drops. Lastly, in experimenting on the action of heat, the incident rays were sometimes made to lose their calorific rays by a concentrated solution of alum, sometimes their luminous rays by a solution of iodine in bi-sulphuret of carbon.

The very first experiment showed that in such drops certain swarmspores often moved in a direct course either to or from the source of light; that the movement often took place with considerable rapidity; that it commenced the moment the preparation was exposed to the influence of the light; that a change in the position of the preparation relatively to the source of light resulted in an immediate corresponding change in the direction of the movement of the spores. It had then to be determined whether any and what share in these movements was so due to currents within the drop, and with this object the same experiments were repeated with emulsion drops. The currents, which could then be easily detected in the drop, were, however, under the same conditions and in the same localities, not to one side only as in the case of swarmspores, but always in a very different direction, namely, towards a common centre.

Stronger evidence that active movements were the cause of the grouping of the swarmspores in the drops was furnished by experiments in which different spores in the same drop were exposed to light from one side; when some went towards the light, whilst the others removed from it or remained perfectly still. Of the same nature were the results of experiments made with finely divided inorganic substances (amorphous bromine) and with swarmspores which had been killed by heat or by slight admixture with a noxious substance; they showed none of the movements which were displayed by the living spores in drops of water.

Having thus settled the general phenomenon, Strasburger proceeded to the special examination of the behaviour of different swarmspores under light. For this purpose he used chiefly those of *Hæmatococcus lacustris*, *Ulothrix zonata*, *Chaetomorpha acreea*, *Ulva enteromorpha*, *lanceolata* and β *compressa*, *Ulva Lactuca*, *Botrydium granularum*, *Bryopsis plumosa*, *Ædogonium* and *Vaucheria*, *Scytosiphon lomentarium*, *Chytridium*, and *Saprolegnia*, the swarmspore conditions of *Chilomonas curvata* and *Paramecium*, and others. The behaviour of these numerous swarmspores with respect to light was examined under widely differing conditions. He also examined their behaviour in the dark, the effect of heat and other external influences, that of currents

* See this Journal, i. (1878) 197.

in distributing the spores in large vessels, and the effect of light on the movements of other plant-organs.

The following are the general results arrived at:—

The direction of the movement of certain swarmspores is influenced by the light: these may be termed *phototactic*. This action is connected only with the protoplasm as such, and not with any definite colouring matter, for colourless spores act like coloured ones.

The swarmspores affected by light move in the direction of the incidence of the light, and this takes place in two ways: either it is constant only in the direction of the source of light even when the intensity of the light decreases in this direction, when the swarmspores may be called *aphotometric*; or they follow the decrease of light in the direction of rising or falling intensity, when they may be called *photometric*. No movement is possible in any other direction than that of the incidence of the light, even when the intensity of the illumination rises or falls in any other direction.

The blue, indigo, and violet rays alone have any influence on the phototactic spores, and the maximum effect is produced by the indigo. On the other hand, the yellow and nearly allied rays of sufficient intensity cause a quivering movement in phototactic spores.

On a sudden change in the brightness, many phototactic swarmspores show after effects, the direction of the movement induced by the previous degree of brightness being retained for a short time.

The large swarmspores of *Bryopsis* show after effects only when the intensity of the light is suddenly diminished; when it is suddenly increased, they exhibit a trembling which makes them leave their course for a while. Those of *Botrydium* do not show after effects when the brightness is either suddenly increased or decreased, but they tremble if the light is suddenly cut off. The swarmspores of *Ulva* gave no sign either of after effect or trembling.

An increase in the intensity of the light occasions in the phototactic spores for the most part a tendency to settle; direct sunlight more particularly acts in this way; decrease in the intensity of the light heightens their mobility.

The rapidity of the movement is not influenced by light; the spores, however, move in a more direct course the greater the intensity of the light.

In general, moreover, the smaller spores move straighter than the larger ones. The largest, by virtue of their important property of moving in considerable masses, have freed themselves from the influence of light on their direction. But there are also small spores which are influenced comparatively slightly, or not at all, by light.

In the dark the phototactic swarmspores do not settle to rest unless they are sexually differentiated and unite with one another. Otherwise they continue to move till they disappear.

In swarmspores brought from the dark into the light, similar effects may be observed as when subjected to a sudden increase in the brightness.

In general, photometric swarmspores alter in their sensitiveness to light in the course of their development, this being displayed more

when they are young than when they are old; and it exhibits also other variations.

Apart from the alteration in sensitiveness during development, whole batches show themselves to be directly sensible to relatively higher or lesser intensities of light. This appears to depend on the intensity of the light in the spot where they were produced.

Heat exercises for the most part an influence on the photometric sensitiveness of swarmspores. As the temperature rises they become in general more sensitive to light, less so as it sinks.

If there is not a free current of air through the batches, photometric swarmspores are sensitive to higher intensities of light.

Insufficient nutriment prevents the swarmspores from coming to rest, without influencing their sensitiveness for light.*

Floating Algæ forming Scum on the Surface of Water.—The cause of the sudden appearance of green, red, or brown scum on the surface of water, when due to an algaoid growth, must be either an extraordinarily rapid multiplication of the alga, or a change in its specific gravity, in consequence of which it rises from the bottom to the surface of water, such as occurs also in the terminal buds of flowering water-plants, as *Hydrocharis*, *Stratiotes*, *Ceratophyllum*, *Myriophyllum*, *Aldrovanda*, *Utricularia*, &c. The organism which constitutes this "Wasser-blüthe" is usually some green alga belonging to the Chroococcaceæ, Oscillatorieæ, or Nostocaceæ. Professor F. Cohn has for the first time detected a *Rivularia* † as the cause of this appearance, on a stream near Lauenburg, in Pomerania, the surface of which was completely covered with a green scum, consisting of an innumerable quantity of minute globes from 0.15 to 0.3 mm. in diameter, bearing a superficial resemblance to *Volvox*. Under the Microscope they were found to consist of *Rivularia*-filaments imbedded in jelly, formed of ordinary cells and heterocysts. Cohn considers it a new species, to which he gives the name *Rivularia fluitans*.

About the same time, C. Gobi, of St. Petersburg ‡ observed a similar appearance on the surface of the sea-water in the Gulf of Finland, consisting also of minute green globes from 0.3 to 0.45 mm. in diameter or larger, enclosed in a very thin jelly, to which he gave the name *Rivularia pelagica*. The two species were subsequently determined by Professor Cohn to be indistinguishable from one another. The marine form was seen only when the water was tolerably still, disappearing completely when it became rough, and was accompanied by large patches of another green alga, *Aphanizomenon flos-aquæ* Rlfs., which had hitherto been observed only in fresh or brackish water.

Luminous Bacteria in Meat.—An account has been published § of some observations of M. Nuesch on "Luminous Bacteria on Fresh Meat." A fact of the same kind was noted by the famous Fabricius ab Aquapendente in 1592, who appears to have been the first to observe it. M. Nuesch had some pork chops which were sufficiently

* 'Der Naturforscher,' xi. (1878) 485.

† 'Hedwigia,' xvii. (1878) 1.

‡ Ibid., 33.

§ 'Bull. Sc. Dép. du Nord' (1878) 184.

luminous to enable him to read his watch by their light! On examination, his butcher owned that he first observed it in the recess in which he stored the ‘*débris destinés aux saucisses.*’ Shortly afterwards all his meat became phosphorescent, and even fresh meat brought from a distance to his shop was similarly affected. The moment the meat began to give indications of losing its freshness, the phosphorescence disappeared, and *Bacterium termo* became visible on examination; cooked meat did not put on this appearance, but cooked albumen and potatoes did become phosphorescent, and starch paste became of an orange colour in the presence of this phosphorescent meat; the hands, if rubbed over it, remained phosphorescent for several hours. It is reported that under the Microscope bacteria were observed, and that, in the dark, examination under the Microscope revealed a number of luminous points. In this strange history there are two satisfactory points; the one is that the meat did not differ in smell from ordinary meat, and the other is that we are promised fuller details.

Thuret and Bornet's ‘Phycological Studies.’—This magnificent work surpasses anything which has ever been published relating to Algæ. It comprises fifty-one folio engravings by Picart from drawings of Bornet and Riocreux. Most of the plates were prepared under Thuret's direction between the years 1846 and 1856, and several appeared in a reduced form in the ‘*Annales des Sciences Naturelles*’ of 1851, as illustrations of his article, ‘*Recherches sur les Zoöspores des Algues.*’ It was Thuret's intention to publish an atlas of fifty plates, but, at the time of his premature death, ten of the plates had not been engraved. These were finished under the direction of his friend and co-worker, Dr. Bornet. Never before have the Algæ been so exquisitely delineated, whether microscopically or in gross. The life-size figure of *Fucus platycarpus* is perfection itself. The text is principally by Dr. Bornet, who has inserted when possible the notes and descriptions of Thuret himself. No apology, however, was necessary on the part of the former; for not only was he the constant companion of Thuret, but his style of writing very closely resembles that of his lamented associate. The text modestly purports to be simply a description of the plates. It is, however, much more; it is a very elaborate exposition of the structure and reproduction of the different groups of Algæ. The principal part of the observations on the Fucaceæ have already appeared in the ‘*Annales.*’ The part relating to the Phæosporeæ is very clearly presented, and is the most complete account of the order yet published. The fertilization of *Polyides rotundus* resembles that of *Dudresnaya* in the growth of a number of filaments from the base of the trichogyne. The account of the reproduction in the Corallineæ throws a new light on the structure of that order, and for the first time a detailed account is given of the antheridia and cystocarpic spores.*

Relation of Lichens to Algæ and Fungi.—The theory of Schwendener, that lichens are not independent organisms, but consist

* ‘*Am. Journ. Sci. and Arts.*’ xvii. (1879) 256.

of fungi parasitic upon Algæ, although not generally accepted by lichenologists, has met with great favour from physiologists. Dr. A. Minks promises an important work in opposition to this theory, founded on a long series of experiments, and to be illustrated by a large number of coloured plates. In the meantime he gives a statement of his conclusions, with some of the arguments on which they are founded, in 'Flora.'* His observations were made mainly on a gelatinous lichen, *Leptogium myochroum*, Ehrh., and with a Hartnack's objective with a power of 1250. All the preparations were made in filtered river-water, to which was usually added a larger or smaller quantity of potash ("liquor kali caustici" of the German pharmacopœia, 33½ per cent.). In order to remove the jelly, the preparation was further heated with potash for ten minutes, every trace of the alkali washed away, and dilute sulphuric acid gradually added to the water in which the preparation lay. While the destructive influence of the acid on the true constituents of the lichen is very slow, it has a remarkable effect on the contents of the cells, changing the blue-green of the gonidia at once into a more or less intense steel-blue.

A close observation of the thallus of the lichen in question shows, says Dr. Minks, that there is no clear distinction between the cells of the hyphæ and the gonidia, one passing over insensibly into the other, the two being contrasted simply as different modifications of the same cell. The cloudy granular contents of the gonidia appear, when very highly magnified, as a colourless protoplasm permeated by a smaller or larger quantity of intensely blue-green corpuscles. The colourless contents of the hyphal cells also consist of a protoplasm, but in their axis is a single row of similar but more delicate blue-green corpuscles. The presence of these corpuscles, termed by Körben *microgonidia*, serve to distinguish the cells of lichens from those of fungi, and are the origin of all intracellular new-formation of cells. The *microgonidia* may be considered as the germ of the new-formation of gonidial chains. A row of *microgonidia*, increasing by the division of its separate corpuscles, increases the size of the cell which encloses it to its utmost capacity; this mother-cell ultimately becomes dissolved into jelly, and the young chain of gonidial cells is thus set free. The *microgonidia* gradually grow and finally become invested each in its own cell-wall, becoming thus transformed into ordinary gonidia. In this way an ordinary hypha of the thallus may become transformed into a chain of gonidia. The gonidial cells soon lose all indication of their origin, and increase by the ordinary repeated bipartition or quadripartition. Some cells, however, take no part in this multiplication, remaining unchanged in the form of what are known as *heterocysts* or *metrogonidia*, which also contain *microgonidia*, like the ordinary cells. The two differentiated products from the same original fundamental tissue—ordinarily called the gonidial system and the hyphal system—our author proposes to term *gonidema* and *gono-hyphema*, the latter always having a potentiality to pass over, at some time or other, into the former. In addition to these, the lichen-thallus contains a third tissue, hitherto neglected, the

* 'Flora,' xxxvi. (1872) 209 *et seq.*

hyphema, the original fundamental tissue out of which the gonohyphæ are themselves differentiated. This can be best detected in the hypothalline tissue, at the point of origin of the rhizines. Its cells are very minute, and have not the elongated form of those of the gonohyphæ, but contain, like them, microgonidia. It will be observed that the structure and development of *Nostoc* agree, in every essential respect, with that just described of ordinary lichens.

In addition to the ordinary mode of reproduction of the thallus of lichens which the author terms *blastesis*, there is another which is less known, and to which he specially calls attention. The bodies which he calls *hormospores*, now described for the first time, are similar in their mode of origin to the stylospores or teleutospores of fungi. They are colourless, and contain a number of moderately large microgonidia, and are produced on the rhizines and other parts of the lichen, as the terminal cells of special hyphæ. When about to propagate, the hormospore divides into a number of cells, the microgonidia at the same time also increasing rapidly. The mother-cell then deliquesces into a jelly, the microgonidia at the same time developing into metrogonidia.

The peculiarity of lichens, which distinguishes them from every other class of vegetable productions, is that all the three kinds of tissue above described are capable of independent reproduction; but that no one of the three can itself reproduce a lichen. A combination of all three is necessary for this purpose; and this is the cause of the remarkable appearance which has given rise to the theory that a lichen is a compound structure of one organism parasitic upon another.

In a subsequent paper* the well-known lichenologist, Dr. J. Müller, of Geneva, confirms Dr. Minks's statement as to the development of the gonidia of lichens out of microgonidia. He states that he has been able to make out the microgonidia with ease, with a Swift's $\frac{1}{8}$ -inch objective (a power of 360), after subjecting the lichen to the chemical treatment recommended by Dr. Minks; and with Hartnack's immersions No. 10 and No. 15 without any chemical preparation, in both fresh and dried lichens. Dr. Müller detected microgonidia in all the cells, both vegetative and reproductive, of the entire lichen; in the rhizines, cortical cells, medullary hyphæ, paraphyses, young asci, spores, basidia, and spermatia, but most distinctly in the medullary hyphæ, where they form a light greenish bead-like chain or row of minute balls in the axis of the hyphæ, with a diameter of about $\frac{1}{2000}$ to $\frac{3}{2000}$ mm. They are still more easily seen in the hyphæ of heteromerous lichens, as *Physcia* and *Parmelia*; and they can also be made out without difficulty in vertical sections through the thallus of crustaceous and foliaceous lichens. Intermediate conditions in all stages may be observed between microgonidia and gonidia, which gradually become free by absorption of the hyphæ, and then divide. Dr. Müller concludes, therefore, that the gonidia of lichens are not foreign bodies imbedded in their tissue, but that they originate in the hyphæ, as the spores in the asci.

* 'Flora,' xxxvi. (1878) 479.

After many unsatisfactory attempts with dry objectives, and inferior powers, but with some attention to chemical preparation of the material, Mr. E. Tuckerman, of the United States, says* that he has at last had the pleasure, with an immersion $\frac{1}{8}$ of Tolles, to clearly discern the pale greenish, broken column, passing into rounded, microgonidium-like masses, contained in, and seen at length to escape from, the medullary hyphæ of the *Parmelia* of Wright Lich. Cub. n. 74 (there called by him *P. tiliacea*, v. *flavicans*, and supposed the same with the *P. relicina*, at least of Montagne), reaching this result with a power of only some six hundred diameters, and without other preparation than a thorough maceration of the tissue in water. With a $\frac{1}{16}$ of Tolles, a 1-inch eye-piece, and power of about 1000, the whole structure and especially the colour, was better exhibited; as it was best of all in Tolles's admirable $\frac{1}{16}$ and $\frac{1}{25}$.

Influence of Light on Fungi.—The common idea that not only can fungi live without the influence of light, but that it is actually injurious to them, is contested by S. Schulzer, of Muggenburg,† who points out, in support of his view, the following facts. The common *Sphaeria compressa* grows upon wood, originating at various depths below the surface. When it first makes its appearance, at a distance from the light, the perithecium is inconspicuous, thin, and colourless, becoming thick and dark-coloured only on exposure to light; and the same is true of several other Sphæriaceæ. *Cortinarius fulgens* and *C. cyanus* change their colour, as they mature, the one from light yellow, the other from violet, to brown, and this can be shown to be due to the influence of light, and not merely to age. Many fungi which are light-coloured and weak when buried in grass or underwood, are much more vigorous and of a darker colour when exposed to a stronger light. *Peziza Fuckeliana* always grows in an oblique direction towards the light, the stem becoming curved in a serpentine manner if its position in reference to the source of light is altered from time to time. It exhibits, in fact, a distinct positive heliotropism. Finally, a considerable number of the perennial hard Hymenomycetes belonging to the Polyporei, are able completely to develop their fructification only when freely exposed to light.

Spores on the upper side of the Pileus in Hymenomycetes.—The occurrence of a thick layer of spores on the upper side of the pileus—under circumstances where they cannot have fallen down from some other individual—has been observed in a single exotic genus of Agaricini, *Stylobates* Fr., and in several species of Polyporei, especially belonging to the genera *Polyporus* and *Boletus*. No explanation has been afforded of this singular circumstance before the recent observations of S. Schulzer.‡ In a species newly discovered by him, *Polyporus adpersus*, and subsequently in several other species, he observed that while some of the horizontal hyphæ of the pileus bend downwards towards the hymenial layer consisting

* 'Am. Jour. Sci. and Arts,' xvii. (1859) 254.

† 'Flora,' xxxvi. (1878) 119.

‡ Ibid., 11.

of the tubes on the under surface, where their extremities form the basidia and basidiospores, others bend upwards to the upper surface of the pileus, above which their delicate hyaline extremities project to the extent of from 0.025 to 0.05 mm., and then divide into two or three branches, each of which produces a spore at its extremity. In the species named, these spores resemble in every respect the ordinary purple-brown spores produced within the tubes on the under side of the pileus, while in other species they present some difference. The sporophores are usually somewhat crooked, and after producing the spores, disappear completely, leaving no trace behind, the spores alone remaining as a reddish-brown coating on the upper side of the pileus.

Change of Colour in the Spores of Fungi.—Schulzer records* a singular instance of the spores of a fungus which he considered closely allied to *Agaricus (Hypholoma) cascus*, Fr., changing their colour beneath his eyes from purple-brown to black. The observation was made while testing the correctness of Fries's statement that the colour of fungus-spores appears to vary according to the colour of the substance on which they lie, a statement he was unable to confirm.

Fungi found within the Shell of the Egg.—Dr. O. E. R. Zimmermann contributes to the 'Bericht der naturw. Gesellsch. in Chemnitz' (1878) a complete history of the various fungi which induce putrefaction of the egg. The attack of the fungus is sometimes indicated by small green, yellow, yellowish red, or brown spots on the shell, with internal projections into the albumen; or by yellow or greenish-yellow spots in the albumen itself, which then becomes a slate-coloured fluid, while the yolk passes into tough blackish lumps, accompanied by the offensive odour of sulphuretted hydrogen. These changes are caused by various fungi. Frequently there is found only a sterile thin-walled colourless or thick-walled olive-green mycelium, the cells of which readily separate from one another, or a mucor-mycelium (probably *Mucor racemosus*) propagating by gemmation. Among fructifying fungi, chiefly in the air-chamber at the larger end, were found *Penicillium glaucum*, *Aspergillus glaucus*, *Stysanus stemonitis*, *Echinobotryum atrum*, *Mucor stolonifer*, a *Botrytis*, and a new species, *Macrosporium verruculosum*, as well as bacteria, especially *Bacterium termo* and *Bacillus subtilis*, together with torula-cells, and others similar to those of *Oidium lactis*.†

Fungi parasitic on the Cabbage.—Under the title 'Plasmodiophora Brassicæ, Urheber der Kohlpflanzen - Hernie,'‡ Woronin publishes a treatise, illustrated with six plates, in which he describes the cause of the "club" disease so common on the root of the cabbage. It is a fungus, to which he gives the name Plasmodiophora, the simplest form hitherto known of the Myxomycetes. It consists of a minute mass of protoplasm or plasmodium, which is never enclosed within a cellulose envelope, but breaks up eventually into a great number of

* 'Flora,' xxxvi. (1878) 471.

† 'Hedwigia,' xvii. (1878) 190.

‡ 'Jahrl. f. wiss. Bot.,' xi. (1878) 548.

small spores, each of which becomes a myxamœba. These penetrate into the tissue of the root, and develop into a new plasmodium, though whether by the coalescence of a number of myxamœbæ is still uncertain. In addition to the Plasmodiophora, Woronin found in the diseased roots a new *Chytridium* (*C. Brassicæ*), propagated by zoospores. The zoosporangium has a globular base, and is elongated above into a long neck, which opens to allow the escape of the zoospores, usually outside the tissue of the host. Resting-spores were also observed, probably formed, as in other Chytridiaceæ, by the coalescence of two zoospores, though Woronin has not at present been able actually to detect this process. Similar malformations found on the roots of many other plants, especially Leguminosæ, are probably due to the attacks of fungi of the same nature.

Fungus Disease in Lettuces (*Peronospora gangliiformis*).—Referring to this subject (see page 167), MM. Bergeret and Moreau have found* that water very slightly acidulated with nitric acid constitutes a good remedy for the disease. This solution has the double advantage of being a manure for the soil, and a poison to the fungus; or at least a means of arresting its development.

Fungi of Stalactites.—Fungi play an important and hitherto unnoticed part in stalactitic distortion. In an account† of an exploration of the Luray Cavern, Virginia, U.S., Mr. H. C. Hovey says that his attention was called to numerous fine elastic bristles growing on stalactites and other kinds of dripstone in all parts of the cavern. Each carried a little ball at its extremity usually enveloped by a globule of water, and he further observed that the conditions often favoured a thin deposit of the carbonate of lime on these bristles, so that their shape remained after the substance had decayed. Many of these black setæ and white filaments were examined by the Microscope, and the gradations were traced from the finest hairs up to great knots and tangled outgrowths.

This fungus is a new species of *Mucor*, to which he gives the name of *M. stalactitis*. Sporangia globose, membranaceous, dehiscing by a fissure, terminating threads; sporidia sub-globose and separating; flocci tubular, indistinctly partitional, sometimes branching at the base, but never at the apex. Specific marks: Sub-solitary threads; sporangia simple; height $\frac{1}{10}$ to $\frac{1}{2}$ inch; colour dark olive-green.

Conidial Fructification of Fumago.—W. Zopf has written a treatise on this subject,‡ in which he showed that the conidial fructification of this fungus is obtained only when it is cultivated on a substratum of a highly nourishing character. When the supply of nutriment is deficient, three forms may be obtained; the yeast-like budding-plants, in a fluid; the mycoderma and chalara-like forms, on the surface of a fluid; and mycelial plants bearing micro-gonidia (aerial form), on a solid dry substratum. He had never, notwithstanding long trials, been able to obtain the large-spored pycnidia or the asci.

* 'Comptes Rendus,' lxxxviii. (1879) 429.

† 'Scientific American' (1879).

‡ 'Hedwigia,' xvii. (1878) 100.

Homology of the "Nucule" of Characeæ.—The female organ of Characeæ, variously termed nucule, oogonium, and archegonium, has been treated by A. Braun, Sachs, and others, as a metamorphosed shoot; whence the ordinary German appellation of "Sporensprösschen." In 'Flora' * Celakovsky gives reasons for regarding the enclosed (behüllte) oogonium, as he prefers to call it, as homologous morphologically with the globule or male organ, viz. a metamorphosed foliar structure or portion of a leaf, and consequently homologous also with the ovule of flowering plants.

Arrangement of the Cells in the flat Prothallia of Ferns.—In a series of observations on this subject, † Dr. Prantl states that the first divisions which convert a filament into a plate of cells are not determined by its position with respect to light nor with respect to gravitation; the subsequent position of the plate at right angles to the incident light being the result of torsion. In those prothallia which possess a meristem, its cells are distinguished by their smaller size, denser protoplasm, and more frequent division; these prothallia, therefore, grow more rapidly than those that are ameristic. The absence of meristem is generally the result of a deficiency either of light or of water. Archegonia are formed especially in the neighbourhood of a meristem, from cells which have just been produced from the meristem, and therefore usually arise in acropetal succession. The absence of archegonia is generally due to the want of meristem. The antheridia of ferns are, on the other hand, trichomes, and may spring from any of the older cells, and may consequently occur on ameristic prothallia. Prantl completely confirms Sachs's statement that the new division-wall is always nearly vertical to that from which it springs; and this is even the case in the wedge-shaped apical cell.

The position and extent of the meristem vary in different prothallia. In some it occupies the larger part or even the whole of the free margin, and may then be termed marginal meristem. In others it occupies only a small portion of the margin near the apex, and is then an apical meristem. This meristem passes gradually into permanent tissue, there being no sharp line of demarcation between them. A single cell of the apical meristem which possesses the merismatic property in excess, and every division of which helps to form the curve of the margin, is known as the apical cell; but it is often a matter of great difficulty to distinguish the apical cell from its neighbours. The absolute increase of the cells Prantl found to be less, the smaller the size of the cells, and consequently least in the meristem; while the increase in proportion to the size of the cell is greatest in the meristem, and sometimes greatest of all in the apical cell itself.

Apogamous Ferns and the Phenomenon of Apogamy in general.—Professor A. De Bary, in an article bearing the above title, in the 'Botanische Zeitung,' ‡ gives the results of his observations on non-sexual reproduction in ferns as first described in 1874 by Dr. Farlow.

* 'Flora,' xxxvi. (1878) p. 49 *et seq.*

† Ibid., 497.

‡ July 19th, 1878, *et seq.*

It was then shown that, in some cases, the prothalli of *Pteris cretica*, instead of the usual growth from a fertilized archegonium-cell, produced ordinary buds, from which the new fern plant developed without any sexual action whatever. The observations now published by De Bary were made with the intention of ascertaining more in detail the frequency with which the non-sexual mode of reproduction occurred in ferns, and its relation to similar processes in other groups of the vegetable kingdom.

He found, on sowing the spores of *Pteris cretica*, obtained both from cultivated plants of that species and from forms which grew wild in Italy, that, in all cases, the prothalli produced only the non-sexual buds, to which he gives the name of "Farlowsche Sprossung." In the few cases where antheridia, archegonia, and the normal embryonic development apparently occurred, he found, by watching the further development of the fern, that the prothalli were not those of *Pteris cretica*, but came from the spores of other species which had accidentally found their way into the cultures. Of the different species studied by De Bary, in thirty-four, exclusive of varieties, only the normal development by embryo-formation in the central cell of the archegonium was observed; in three, *Aspidium Filix-mas* var. *cristatum*, *Aspidium falcatum*, and *Pteris cretica*, only the non-sexual budding. The prothalli of *Pteris cretica* may or may not bear antheridia. When present, they have the same structure as in the typical *Polypodiaceae*. In by far the majority of cases there are no traces of archegonia, even in a rudimentary condition. Out of hundreds of cases, only seven were found with archegonia, and they all aborted. *Aspidium Filix-mas* perfectly resembles *Pteris cretica* in the distribution of antheridia and archegonia, but in *Aspidium falcatum* archegonia occurred in at least 25 or 30 per cent. of the prothalli. Although in the cases observed they had all aborted, De Bary thinks it possible that cases may occur in which the normal embryo-formation takes place, which is hardly possible in the two species first named.

The budding process, in all three cases, consists in the formation of a protuberance on the under surface of the prothallus, from which grow a first leaf, root, and stem-bud as in the normal embryo-formation, although their relative position and date of development vary. The protuberance is generally found just at the back of the sinus, where the fertilized archegonium normally occurs. Variations were seen in which the first leaf grew from the upper surface of the prothallus, and, at times, two leaves were produced, one on the upper and one on the lower surface. Secondary forms may be produced upon elongations of the lateral lobes of the prothallus. Some of the more peculiar forms are figured in the plate which accompanies the article. In the three species under consideration, as the normal reproduction by an embryonal growth has been lost, and another, non-sexual form of reproduction has taken its place, we may infer that they have descended from some ancestral form in which the sexual mode of reproduction existed. This is illustrated by the case of *Aspidium Filix-mas* var. *cristatum*, which is undoubtedly derived from the typical *Aspidium Filix-mas*, in which only sexual reproduction is

known. If, however, we adopt the view recently advanced by Pringsheim, that ferns were originally composed of "Bionten," some of which were sexual and some non-sexual, and which alternate more or less regularly with one another, we must consider that, instead of having acquired a new power, the ferns which reproduce by budding represent a case of atavism.

De Bary gives the name of *Apogamy* to this substitution of some other form of reproduction in cases where the power of sexual reproduction has been lost. This condition is found in all parts of the vegetable kingdom, and occurs in single species whose nearest allies reproduce normally. Apogamy is of three kinds: *apogeny*, where the function of both male and female organs is destroyed; *apogyny*, loss of reproductive power in the female, *apandry*, in the male organ.

Chara crinita is a good instance of *apandry* with parthenogenesis, that is of regular embryo-formation from an unfertilized ovule. The female of this species is alone known in northern Europe, yet it fruits abundantly. It has been studied by De Bary in specimens artificially grown in his laboratory; and there is no doubt that here it is not a question of the partial suppression but of the total loss of the male organs. In ferns we have the best instances of a substitution of a shoot for the normal sexual growth. To the same category belong some of the mosses usually called sterile, that is destitute of capsular growths. In the mosses, however, it is a question not yet settled whether there is a total loss or only a partial suppression of sexual reproduction.

In *Funkia* and *Allium fragrans*, in the seeds of which Strassburger discovered adventive embryos, we have something similar to the apogamous ferns; first, in the presence of apparently regularly formed but functionless female organs; secondly, in the presence of apparently active pollen; and, thirdly, in the substitution of adventive embryos for the regular embryo-formation. *Citrus* and *Cæleboqyne*, in which Strasburger also found adventive embryos, probably belong to the same class as *Allium* and *Funkia*, as may also species like *Euonymus latifolius*, many *Ardisiæ*, &c., in which polyembryony often occurs. To these are to be added the numerous species, varieties, and races of cultivated plants which rarely produce seeds, but instead have a correspondingly richer reproduction by shoots. If, as seems tolerably certain, sexual reproduction is requisite to the constant propagation of species, we must regard apogamy as a degenerate condition, in which the conditions of propagation are unfavourable. In this connection, however, we must not overlook the fact that in species with budding or non-sexual reproduction this offspring is produced in surpassing profusion.*

Apogamy in Isoetes. — The phenomenon of apogamy appears, according to the statement of K. Goebel,† to extend also to *Isoetes*. In two species, *I. lacustris* and *echinospora*, he observed, on a large number of specimens, that both macrosporangia and microsporangia

* 'Amer. Jour. Sci. and Arts,' xvi. (1878) 401.

† 'Botanische Zeitung,' xxxvii. (1879) 1.

were replaced by young plants, occupying the same position, springing, namely, from the fovea of the leaf. These were not the product of the germination of the macrospores within their sporangium, the macrosporangium being entirely suppressed. In their rudimentary stage these non-sexually produced plants are simply conical emergences, altogether resembling the rudiments of sporangia, but they gradually develop into plants with ordinary leaves. These shoots are not analogous to the bulbils which characterize many classes of vascular cryptogams, such as Lycopodiaceæ and Ferns, in which the Isoetæ appear to be exceptionally entirely deficient, a phenomenon closely connected with the absence of branching. It is rather an instance of "apogamy" carried out to its most complete stage, namely, the complete suppression, not only of the sexual organs, but of the entire sexual generation.

MICROSCOPY, &c.

Microscopes with Swinging Tailpiece. — This addition to the Microscope has been revived within the last few years, and its novelty having been the subject of some discussion, we have referred to the provisional specification (not further proceeded with) of Mr. Thomas Grubb, at the office of the Commissioners of Patents, in July, 1854. The nature of the invention was thereby declared to "consist in the addition of a graduated sectoral arc to Microscopes concentric to the plane of the object 'in situ,' on which either a prism or other suitable illuminator is made to slide, thereby producing every kind of illumination required for microscopic examination, and also the means of registering or applying any definite angle of illumination at pleasure."

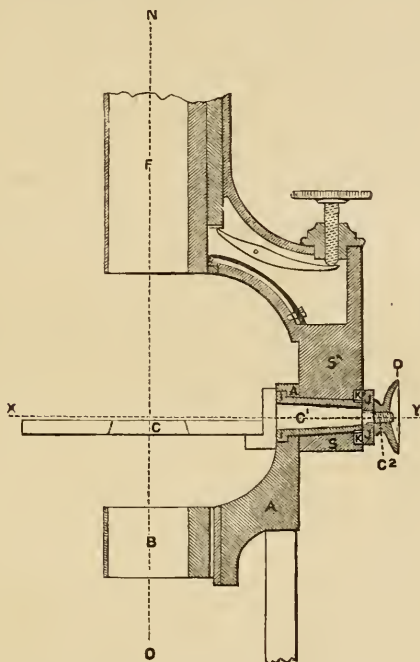
On 1st August, 1876, letters patent were granted to Mr. John Stuart (on behalf of Mr. Zentmayer, of Philadelphia) for improvements in Microscopes by means of which the sub-stage carrying the illuminating apparatus and accessories (together with the mirror if desired) and also the object stage may be placed at any required angle in relation to the optical axis of the Microscope and object-glass, and also at an angle in relation to each other for the purpose of more conveniently illuminating and viewing the object under examination, more particularly when oblique illumination is required.

The invention consists of a method by means of which the stem which carries the sub-stage and the mirror may be made to swing sideways to the right or left, either below or above the stage on a centre having for its axis of rotation a line in the plane of the object on the stage intersected by the optical axis, that is, a line passing through the centre of the body and the object-glass of the Microscope. The stage is also made to turn independently on a separate pivot, having for its axis of rotation the aforesaid line.

The figure represents in sectional elevation a portion of the Microscope.

S is the limb carrying the body with coarse and fine adjustments. A is the stem which carries the sub-stage B, and mirror if required. A is attached to S by the sleeve or socket I, clamped by the nut J,

and on I, A may be swung sideways in either direction to the right or left either below or above the stage, the axis of revolution of which is the line X Y, that is, a line in the plane of the object to be viewed on the stage C, intersected by the optical axis of the instrument, that is, the line N O, passing through the centre of the body and the



object-glass of the microscope. The stage C is also attached to S by the pin C¹, terminated by the screen C², which pin passes through the centre of the socket I, and turns therein so that the stage C may be made to turn in either direction in conjunction with or independent of A, the axis of its revolution being also the line X Y.

By this arrangement the stage C and the stem A may be set at an angle to the axis of the microscope either below or above X Y, intersecting the plane of the object to be viewed and also relative to each other, and when so set the stage C may be clamped at the desired angle by the nut D on the screw C², acting on S and the collar K.

The specification then proceeds (in the language usual in such cases):—

“ Having thus particularly described and ascertained the nature of the said invention and the manner in which the same may be performed or carried into effect, I would remark that I am aware that microscopes have been heretofore made in which a stem or tail-piece has been applied so as to swing from a centre situate below the plane of the object stage, and therefore no claim is herein made in general

to a stem or tail-piece made so as to be swung in this position, but the invention which I consider to be novel and therefore desire to be secured to me by the herein in part recited letters patent, is—

“First. The making the stem A, which carries the sub-stage B, to swing to the right or to the left either below or above the stage of the microscope on a centre sleeve socket or joint I, the axis of revolution whereof is the line X Y, in the plane of the object to be viewed on the stage C, intersected by the optical axis, that is, the line N O, passing through the centre of the body F and the object-glass of the microscope, substantially as described and shown in the drawing.

“Secondly. The arrangement herein described and shown in the drawing for enabling the object-stage C to swivel or turn on a centre or pivot within the sleeve or socket I, so that the axis of rotation of the object-stage C shall be from the same centre as that on which the stem or part A turns to the right or left, and the method of clamping the object-stage C in the required angle, as herein described and shown in the drawings.”

“Penetration” of Wide-angled Objectives.—It has been objected to wide-angled lenses that they possess less penetrating power, or, more properly, less depth of focus than narrow-angled lenses; that is to say, that the layer of an object, that can be seen without change of focus, is thinner with wide than with narrow-angled lenses.

Dr. Blackham, the President of the Dunkirk (U.S.) Microscopical Society, says that if this were true it would be an argument in favour of the wide-angled lenses, instead of against them; in reality, however, it does not depend upon the aperture, but is only residual spherical aberration, which can be left in and distributed in a wide-angled lens as well as in a narrow-angled one. This will be readily appreciated upon considering the action of an uncorrected plano-convex lens of crown glass. The rays from the nearer surface of the object which impinge upon the peripheral portions of the lens would, if the lens were free from spherical aberration, be brought to a focus further back than those from the further surface of the object which impinge upon the central portions of the lens. As it is, however, they are brought to the same focus, by reason of the spherical aberration. Such a lens has a good deal of *penetrating* power, or depth of focus, but its definition is not satisfactory. The same holds true of all objectives possessed of penetrating power, whatever their angular aperture. The only legitimate method of obtaining depth of focus or “penetration” is by increasing the anterior conjugate focus or frontal distance, so that the thickness of the layer that it is desired to see on each side of the true focal plane may be relatively small. Thus a 1-inch objective with an anterior focus of $\cdot 317$ of an inch will bear amplification up to 400 diameters, and at that power might properly show, with reasonable clearness, a layer of the object on each side of the true focal plane much thicker than that which a one-fifth with only $\cdot 018$ of an inch of anterior focus ought to show at the same amplification. It is perhaps true that, by skilful management, the residual spherical aberration can be so distributed, that several planes of an object can be in view at once; but this is always at the

sacrifice of definition, and, as the better the image the more noticeable do errors resulting from this plan of overlapping several of them become, wide-angled glasses show the defects of this plan more markedly than narrow-angled lenses, whence has arisen the fallacy that narrow-angled lenses are possessed of an inherent property of "penetration" and a residual error has been lauded as a virtue.*

Process for Measuring the Solid Angles of Microscopic Crystals.—In the 'Bulletin de la Société Minéralogique de France' (1878, No. 4, p. 68) M. Thoulet gives the following method for measuring the solid angles of microscopic crystals:—

If, in a tetrahedron, we know the lengths of the six edges, we can ascertain the angles of the faces surrounding the same summit, and can consequently resolve the spherical triangle whose sides are respectively the angles of the faces of the tetrahedron, and whose angles are the dihedral angles of the edges of this same tetrahedron.

We place the crystal (which may be isolated or contained in a thin plate of rock) in any given position under the Microscope, and choose four special points, two on the edge, and the others respectively on one and the other of the two planes whose angle is to be measured. By means of the fine adjustment of the microscope, we successively bring into focus each of these summits, and note the vertical displacement in each case by the milled head.

Without moving the crystal, we replace the eye-piece by a camera lucida, and make a drawing of the crystal, marking very accurately by pricks the position of the four points; then the crystal is replaced by a stage micrometer, which will make a scale of the drawing to be made.

We now possess all the data necessary to calculate the solid angle. Each of the sides of the tetrahedron is determined: 1st, by its horizontal projection on the drawing; 2nd, by the difference in the vertical height of its two extremities, as indicated by the fine adjustment.

The rest of the work is only a trigonometrical calculation of three rectilinear triangles, whose three sides are known, and of which one of the angles has to be found, and, finally, the calculation of a spherical triangle whose three sides are known, and one of the angles of which is to be found.

Instead of drawing the whole crystal, it is evident that it would suffice to note the four essential points; the complete drawing, however, allows a subsequent verification, which is often necessary, and, besides, enables us to decide as to the crystallographic notations to be given to the crystalline face.

The solid angles of crystals having dimensions less than $\frac{1}{100}$ of a millimetre can be measured to less than a degree by this method.†

Method of Isolating the Connective-Tissue Bundles of the Skin.

—Dr. George Thin, in a paper communicated to the Royal Society,‡ describes the method he has made use of for this object.

* From a paper read by Dr. Blackham before the Indianapolis Congress. Cf. a French translation in 'Journal de Micrographie,' iii. (1879).

† 'Bull. Soc. Belg. de Micr.,' v. (1878) 6.

‡ 'Proc. R. Soc.,' xxviii. (1879) 251.

By the term *bundle*, or *secondary bundle*, Dr. Thin designates the ordinary bundle of authors, which is more or less conspicuous in all preparations of skin, and which is analogous in structure and size to the bundles as usually described and figured in tendon-tissue. The element described by Rollett as "connective-tissue fibre" he describes as *primary bundle*, to distinguish it more markedly from the fibrillæ which compose it. When groups of secondary bundles are isolated, each group being composed of several secondary bundles, he terms the group a *tertiary bundle*.

These elements can be isolated by first saturating the corium with chloride of gold solution, and then macerating the tissue in acids. Portions of skin, with a thick layer of the panniculus adiposus, were taken fresh from the mamma of a middle-aged woman, which had been removed for a tumour of the gland, the portions of skin chosen being well clear of diseased tissues. The stretched skin was pinned down to a cork board, the under surface uppermost, and then saturated with $\frac{1}{2}$ per cent. chloride of gold solution. From time to time different thicknesses of the fatty layer were removed as the solution had had time to penetrate into the tissue, until, finally, the deeper layer of the cutis proper was laid bare. The tissue, still extended, was then placed in fresh gold solution for several hours. The object of the manœuvre was to secure the penetration of the fluid through the bundles, whilst these were still extended in their natural condition.

After a due action of the gold, the skin was cut into small pieces, which were then treated by acetic acid, and then the strength of the acetic acid raised to 20 per cent. of the ordinary concentrated acetic acid of commerce. Other portions were treated by formic acid. Some successful preparations were obtained from portions macerated first for a few days in a mixture of one part formic acid, of specific gravity 1.020, and one of water, and then in the undiluted acid for some days longer, but a strict adherence to these strengths was not found necessary.

Portions of the corium thus prepared were teased out in glycerine and examined directly or after staining by different dyes. Staining by picric acid was found very advantageous.

In this way he was able to isolate in a condition favourable for study the primary, secondary, and tertiary bundles. Generally speaking, although not invariably, the tertiary and secondary bundles were best seen in the tissues macerated in acetic acid, and the secondary and primary bundles in those treated by formic acid.

Numerous elastic fibres were isolated by both methods, the finest fibres more particularly in the formic acid preparation.

Various methods have been recommended by histologists for the demonstration of the ultimate fibrillæ of fibrous tissue, chiefly with reference to those of tendon bundles. Judging by the figures published in histological works, the fibrillæ of the cutis bundles are, Dr. Thin thinks, very seldom seen; the appearances usually observed in skin hardened by chromic acid and alcohol are unfitted for a study of the fibrillæ. In such specimens the bundles are more or less broken up, but the individual fibrillæ are not, as a rule, isolated. He found, however, that they were well shown by the following method:—A

portion of fresh skin, with the panniculus adiposus attached, was pinned to a piece of cork in the manner already described, and treated in the same way, with the exception that this time glycerine, instead of chloride of gold solution, was used for saturation. When the saturated cutis tissue had been laid bare, the whole was placed in glycerine, and allowed to remain in it for several days. Small portions were then teased out in glycerine, stained by picro-carminate of ammonia, and examined in glycerine. In such preparations the secondary bundles were found isolated, the contours of the primary bundles not being preserved. In the secondary bundles the fibrillæ were seen more or less distinctly, in some of them with perfect distinctness.

Process for Preparing the Embryos of Fishes.—The ova of the Salmonidæ are generally employed by embryologists for the study of the development of osseous fishes. It is difficult to observe them in the fresh state, either whole, by transmitted light, on account of the thickness of their envelope, or after having opened them, in consequence of the small consistency of the germ, especially at the commencement of the segmentation. Chromic acid, the reagent most frequently employed to harden these ova, readily alters the young cells, and deforms the embryos by compressing them between the unextensible envelope of the ovum and the solidified vitelline mass. For the last two years M. F. Henneguy * has employed, in the laboratory of comparative embryogeny of the College of France, a process which allows the germs and embryos to be extracted from the ova of Trout and Salmon with the greatest facility, and without subjecting them to the least alteration.

He places the ovum for some minutes in a 1 per cent. solution of osmic acid until it has acquired a light brown colour; then in a small vessel containing Müller's liquid, and opens it in this liquid with a pair of fine scissors. The central vitelline mass, which is coagulated immediately on contact with water, dissolves, on the contrary, in the Müller's liquid, while the solidified germ and cutical layer may be extracted from the ovum, and examined upon a glass plate.

By treating the germ with a solution of methyl-green, and then with glycerine, Mr. Henneguy was able to observe in the cells of segmentation the very delicate phenomena lately pointed out by Auerbach, Bütschli, Strasburger, Hertwig, &c., and which accompany the division of the nucleus, namely, the radiated disposition of the protoplasm at the two poles of the cell, the nuclear plate, the bundles of filaments which start from it, and the other succeeding phases.

This fact proves that the treatment undergone by the ovum does not in any way alter the elements of the germ.

To make cross sections of the germs and embryos thus extracted from the ovum, they should be left for some days in Müller's liquid, and coloured with picro-carminate of ammonia. After having dehydrated them by treating them with alcohol of spec. grav. 0.828, and then with absolute alcohol, they are put for twenty-four hours into collodion. The embryo is then placed on a small plate of elder-pith

* 'Revue Internat. des Sci.,' iii. (1879) 150.

soaked with alcohol, and covered with a layer of collodion. When the collodion has acquired a sufficient consistency, very thin sections may be made, comprising both the embryo and the plate of pith; and these are to be preserved in glycerine. If the sections cannot be cut directly, the piece is placed in the 40 per cent. alcohol; the collodion then preserves its consistency, and allows the embryo to be cut at any time.

This process is applicable to every kind of embryo of little thickness, allowing it to be coloured *en masse*. It has the immense advantage of enabling one to see at what level of the embryo each section is made, to preserve it in the middle of a transparent mass, which maintains all the parts, and prevents their being damaged, as very often happens when an inclusory mass is employed, from which the section must be freed before mounting it.

In his 'Précis de Technique Microscopique' M. Mathias Duval has already recommended collodion for embryological researches, but without indicating his mode of employing it. We hope to render a service to embryologists by making known a process which may be of some utility.

Improvement in Aerating Apparatus of Sea-water Aquaria.—Dr. H. Lenz, of Lübeck, has employed with success the following method (suggested to him by Mr. A. Sasse, of Berlin) for producing very minute air-bubbles from the aerating apparatus. The aperture of the glass tube, instead of being drawn out into a fine point, is widened to 6–8 mm., or a glass tube 25 mm. long and 6–8 mm. wide is cemented with sealing-wax on to the short discharging arm. A piece of common sponge is then pressed pretty tightly into the wide opening. Instead of the somewhat large single air-bubbles, we then have hundreds of very small ones in clusters, and the tighter the sponge is pressed in, the smaller they become.

By this means the air is as finely divided as by the syringe apparatus of the large aquaria. Very slight, if any, increase of pressure is found necessary; and should in time algae, &c., become attached to the sponge, it can easily be taken out and cleansed. Dr. Lenz used his sponge for three months before it wanted cleaning.*

Further Improvements in studying the Optical Characters of Minerals.—Mr. H. C. Sorby has lately improved his method of studying the optical characters of minerals. He says:†—

"It is a curious example of how a method may be invented and then lost sight of, that the determination of the index of refraction in the way I have previously described, was proposed by a French savant upwards of a hundred years ago. I have not yet consulted the original publication, but I very strongly suspect that the proposal was more theoretical than practical, and that with the instruments then at disposal the results were found to be so inexact that the whole system became obsolete and practically forgotten. I may, however, claim to have so modified the method, and brought the instrumental means to

* 'Zool. Anzeiger,' ii. (1879) 20.

† 'Mineralogical Magazine,' ii. (1878) 103.

such perfection, as to make it fully equal to the requirements of practical mineralogy. Whilst speaking on this point, it may be well to give an illustration of the accuracy with which it is possible to measure the index with the apparatus which I have now at disposal. Thus, in the case of a specimen of quartz, about $\cdot 372$ inch thick, five different determinations of the index of the ordinary ray for the light transmitted by red glass, which corresponds to the solar line c , were $1\cdot 5513$, $1\cdot 5531$, $1\cdot 5524$, $1\cdot 5531$ and $1\cdot 5513$, so that no observation differed more than a unit in the third place of decimals from the mean value, which may therefore be looked upon as true to the third

place of decimals, assuming that the equation $\mu = \frac{T}{T - d}$ needs no correction.

There was no difficulty in thus proving that there is a slight but well-marked difference in the index for different specimens. The mean for five was $1\cdot 5543$, whereas, according to Rudberg, it is $1\cdot 5418$. In a similar manner I found that my method invariably gave too high a result in the case of other minerals. After many careful measurements I came to the conclusion that this can be satisfactorily attributed to the spherical aberration due to the introduction of a transparent plate in front of the object-glass, as suggested by Professor Stokes. The amount of this error depends partly on the index of refraction, and partly on the special correction of each particular object-glass; and when great accuracy is desired, it is necessary to construct a small table showing the amount that must be deducted in each case. I thus find that, when using my $\frac{2}{3}$ object-glass, if the index is about $1\cdot 5$ I must deduct $\cdot 0100$, and when $2\cdot 0$, must deduct $\cdot 0180$.

Having thus shown how accurately the index may be measured, it may be well to briefly allude to some improvements in the apparatus. I find two cross lines in the focus of the eye lens very useful in keeping constant the focal adjustment of the eye itself. In adjusting the focus of any object it is always arranged so that the cross lines are also in sharp focus. Without this precaution there may be an important difference, according as the focus is adjusted by moving the object-glass up or down. I have also found it desirable to take the means of two or more sets of measurements made in slightly different parts of the scale, so as to eliminate any error due to imperfect graduation. This is easily managed by moving the fine adjustment. It is by adopting these precautions that I have been able to make such concordant and accurate measurements as those given above in the case of quartz, and to prove that the limit of error may be made very small.

When first I commenced to apply my method to the study of various minerals, with the view of comparing mathematical theory with observation, I soon found that there were a few discrepancies. For some time I thought it just possible that these might be due to errors in the measurements, but I found that these discrepancies became the more and more marked as by degrees I was able to remove every apparent source of error. The principal discrepancy is in the case of bi-axial crystals like aragonite, but some are also met with in

the case of uniaxial crystals. I have not yet been able to thoroughly ascertain the laws which govern these special peculiarities, and no kind of explanation has yet suggested itself either to Professor Stokes or myself; and therefore it appears to me undesirable to enter more fully into the question, which relates more to the mathematical theory of light than to practical mineralogy. It may, however, be well to say that the discrepancy to which I refer is in the ratios of the values of the real and apparent indices."

Mr. Sorby gives an illustration of the application of the method to the identification of doubtful minerals, in the case of certain crystals, which he determined to be an unusual secondary form of calcite.

Improved Achromatic Condenser.—Messrs. R. and J. Beck have introduced a modification of the achromatic condenser, in which a series of combinations of lenses are made to revolve excentrically, so as to be brought consecutively into combination with a lower fixed series of lenses. The apertures vary from 40° to 170° , and two of the revolving combinations are truncated and blackened, so as to stop out the central rays to the limits of 60° and 120° .

The latest addition to the instrument consists of the application of a revolving diaphragm, with various sized apertures beneath the entire combinations.

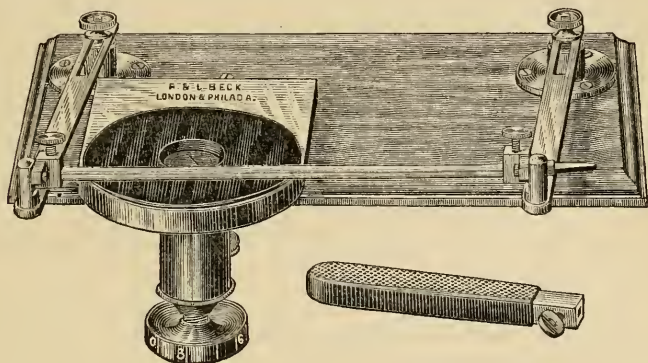
Seiler's Mechanical Microtome.—Dr. Carl Seiler, of Philadelphia, is the inventor of an apparatus for enabling the knife, in cutting sections, to be carried through the tissues with an even motion and at the same inclination—a necessary point to ensure success, but not so easy as might be imagined, because the hands usually are not sufficiently steady without a great deal of practice.

It occurred to Dr. Seiler, therefore, that if the knife could be rigidly fastened to some apparatus by means of which it could be moved over the well of the microtome in the same manner that the hands move it, sections of any size and thinness could easily be made, even by an unpractised hand; and after some experimenting he constructed, with the aid of Mr. Zentmayer, a mechanical microtome which proved to be all that could be desired.

It consists of two rigid, parallel arms of metal, which at one end revolve on pivots attached either to the microtome itself, or to the table to which the microtome is to be clamped. On the other end of these arms are fastened revolving clamps which hold the knife, the edge of which, when in position, rests upon the glass plate of the microtome. The handle of the knife is removed, so as to prevent a slipping and hindrance to the motion of the knife, but can be easily attached by means of a screw, for the purpose of stropping.

When in position and ready for cutting, the knife is pressed upon the glass plate, and a slight side-motion is given to it by the hands, which causes it to pass through the tissue, and cut a thin, even section without difficulty. With this apparatus he was able to cut a thin section of the leg of a five months' foetus, from the knee downward, including the foot, the section measuring 2 inches in length by $\frac{3}{4}$ inch in width. Several mechanical microtomes have been constructed by

various workers, but to his knowledge they are all deficient in one point, viz. the knife or cutting instrument in them is carried through the tissue like a chisel; or, in other words, the cutting edge is pressed through the tissue. But a knife, in order to cut well and evenly,



must be carried through the substance to be cut, especially if it is soft, in a slanting direction, so that each point of the edge describes a curve which is equal to a part of a circle. By referring to the figure it will be seen that in Dr. Seiler's apparatus this is exactly what takes place when the knife is moved, the radius of the curve being the length of the arms from the centre of the clamps to the centre of the pivots.*

Size of Histological Preparations.—Dr. Seiler, in the same article ("Practical Hints on Preparing and Mounting Animal Tissues"), considers that the advantage of having the sections of sufficient size to bring into view the different parts of which it is composed has not as yet received sufficient attention from microscopists, especially from those engaged in the study of pathological histology, and yet it is of the greatest importance, for very frequently a pathological new growth will present different appearances in different parts, and often an erroneous conclusion is arrived at in regard to the nature of the tissue from the fact that but a small section has been examined.

"Microscopy" and "Microscopical" Societies.—Under the title of "Is there a Science of Microscopy?" we gave at page 365 of vol. i. an extract from an article by the Editor of the 'American Quarterly Microscopical Journal,' and stated our intention of adding in a later number a translation of an article by Dr. Kaiser, the Editor of the Berlin 'Zeitschrift für Mikroskopie.' This intention we are obliged to abandon, as we find it impossible to do justice to the author's views within reasonable limits of space, the article occupying twenty-five pages of the German Journal. It must suffice here to say that Dr. Kaiser, after referring to Professor Harting's protest against the use of the word Microscopy, and his attempt to contrast it with Ophthalmoscopy ("the science of observation with

* 'Amer. Quart. Micr. Journ.,' i. (1879) 134.

the naked eye"), defines the former as "a free independent scientific discipline of the natural sciences," and "claims the elementary forms as the original and peculiar domain of special Microscopy."

It seems to us, with all deference to those who have from time to time laboured to define "Microscopy" as some special branch of Biology, that they have been led to a fallacious result, through a pre-conceived idea as to what it would be convenient for the definition to be.

There is, we think, no need to object to "Microscopy" being limited to the Microscope as an instrument (the methods of its application as well as its principles), and the hesitation to admit this has apparently arisen on account of objections that it was thought would then be urged against the existence of a "Microscopical" Society, to which objections, however, there are obvious answers.

The first is, that a "Microscopical" Society, if "Microscopy" refers only to the instrument, is equivalent to a "Lancet" or a "Theodolite" Society.

Even if a Society were established for the single purpose of dealing with the Microscope as an instrument, it would not by any means stand on the same footing as the Lancet or the Theodolite. The Microscope is an instrument *sui generis*, and is not comparable with any other. It is not only as regards its optical principles and mechanical form, but in the various methods of its application, that it might usefully furnish scope for a Society devoted only to those points without regard to any others.*

But further, it is an entire misapprehension if it is supposed that the objects of any known Microscopical Society of the present day are confined to the Microscope as an instrument. The objects of this Society in particular have always been twofold, and have included to an equal extent, to say the least, those branches of natural science conveniently summarized as "the subjects of Microscopical research."

The term "Microscopical," which, as applied to a Society, was no doubt originally used in a sense more nearly agreeing with its strict etymological meaning, has come to be no more than a sign and a symbol, as much as the title of 'Lancet' applied to a newspaper, or those of "Royal" or "Linnean" to a Society.

When this first objection is thus answered, it is then said that another Society for the investigation of subjects of natural history is not required.

It must, however, be obvious that if fifty or twenty-five years ago the Royal Society and the Linnean Society were sufficient to meet the requirements of the biology of that day, the great advance that has been made since that time, and the enormous extension in the ground to be travelled over, is sufficient to justify the existence not of one but of several additional Societies. Notwithstanding that there were

* The most recent instance of the practical benefit to be derived from abstract optical (Microscopical) principles is to be found in the oil-immersion objectives (the origination of which is due to the Treasurer of this Society, Mr. Stephenson), and which are the outcome of the highly technical, and to the biologist no doubt extremely uninteresting discussions on angular aperture, but which have put into his hands a tool which is admitted to mark a greater improvement in the means of investigation than any made since the perfecting of achromatic objectives.

older Societies which covered the same ground, there has been found to be room for another mainly devoting itself to the larger animals—the Vertebrata, and in the same way there was obviously room for one mainly devoting itself to the smaller animals—the Invertebrata, and to the development and minuter structure of the higher forms.

We therefore should define “Microscopy” as the science and art of the Microscope as an instrument both in regard to its theoretical principles and its practical working; but a “Microscopical” Society, as a Society established on the one hand for the improvement of the Microscope and the methods of its application (“Microscopy” proper), and also for the communication of observations and discoveries in the various branches of Biology (Invertebrata, Cryptogamia, Embryology, Histology, &c.), which more especially require the aid of the Microscope for their investigation.

Oil-Immersion Objectives.—We are glad to find that the English opticians are at length turning their attention to these objectives, which it has hitherto been impossible to procure of English manufacture, although we believe we are correct in saying that their construction was primarily urged upon opticians in this country when the idea first suggested itself of the desirability of oil objectives.

Messrs. Powell and Lealand exhibited at the meeting of the Society on the 9th April, an $\frac{1}{8}$ oil-immersion objective of their manufacture, and we believe that the construction of higher powers is being proceeded with.

Method of Preserving Infusoria, &c.—A note by M. A. Certes in ‘Comptes Rendus’* describes a method of obtaining permanent preparations of the Infusoria, which he hopes may help to create collections of which all the Museums of Europe are at present deficient.

The method which he suggests is the employment of the vapour or a solution of osmic acid (2 per cent.), the former, although well known in histology, “never yet having been applied to the Infusoria,”† and he claims that the organisms are instantaneously fixed, so that the least details, cilia, cirrhi, flagella, and buccal armature may be observed with the highest powers, the Euglenæ and Paramecia preserving their characteristic colour. The nucleus and nucleolus stand out clearly, and show, when these occur, the curious phenomena described by Balbiani. The process may be applied successfully not only to the Infusoria, but also to the Rotatoria, Anguillulæ, Bacteria, and Vibrions.

The important point is to make the osmic acid act promptly and with a certain force. Two means are available for obtaining this result with some certainty. The first, which is suitable for most cases, consists in exposing the Infusoria to the vapours of the acid for a period of from ten to thirty minutes. For very contractile Infusoria the process is different, the immediate contact of the osmic acid being obtained by putting a drop of the solution on the cover-glass before placing the latter on the drop of water. The excess

* ‘Comptes Rendus,’ lxxxviii. (1879) 433.

† Compare, however, Dr. Pelletan’s process—this Journal, i. (1878) 189. Also Huxley and Martin’s ‘Biology.’

of liquid is then removed by blotting-paper, and thereby a slight and advantageous pressure produced on the cover-glass.

After the cover-glass is in place, two of the opposite sides should be fastened either with paraffin or Canada balsam to prevent displacement in colouring.

To colour the organisms he uses eosin or Ranvier's picro-carminate. Infusoria previously treated with the osmic acid may be coloured direct with the picro-carminate, but when it is employed alone, it is not easy to control the colouring, so that the preparations often turn out opaque. After several attempts, he found that a mixture of glycerine and picro-carminate will enable any degree of colour to be obtained (glycerine 1 part, water 1 part, picro-carminate 1 part). Introduced suddenly, the glycerine even when diluted frequently produces an abnormal retraction of the tissues, which does not always disappear. Professor Ranvier gives in his 'Histology' a very simple means of avoiding this inconvenience, which M. Certes has employed with success for the most delicate organisms, such as *Oxytricha* and *Stentor*; it consists in placing the preparations, fastened as above described, in a moist-chamber, and putting a drop of carminated glycerine on the edge of the preparation. The water evaporates very slowly, and in twenty-four hours is replaced by the diluted glycerine. By the same process the latter may be replaced by concentrated glycerine, which assures the preservation of the preparations.

All methods of sealing down may be applied. It is, however, better to use dry Canada balsam dissolved in chloroform. The organism to be examined might be at the side of the glass, and this varnish, being thin and perfectly transparent, does not hinder observation even with the highest powers.

Mixture of Oils for Homogeneous-Immersion Objectives.—Professor Abbe points out that in regard to the performance of oil-immersion lenses with *central* light it is a matter of importance to regulate carefully the oil-mixture as regards refraction and dispersion. He noticed some time ago that some of the samples of fennel-oil and olive-oil were rather strong in both respects, so that it is possible that better performance will be got with central illumination when a small additional quantity of olive-oil is added for reducing the refraction to that of the oil of cedar-wood, and then further adding $\frac{1}{3}$ or $\frac{1}{2}$ of cedar-oil to the mixture to reduce the dispersion (the latter specially for thin covers).

New Fluids for Homogeneous Immersion.—The result of Professor Abbe's later experiments will be found at p. 346 of the 'Proceedings.'

Standard Micrometers.—A letter from Professor R. Hitchcock (the editor of the 'American Quarterly Microscopical Journal') on this subject is printed at p. 349 of the 'Proceedings.'

Unit of Micrometry.—The resolution come to by the meeting of the Society on the 9th April will be found at p. 349 of the 'Proceedings.'

OBITUARY.*

SEVEN Fellows have died during the past year, viz.:—Mr. R. J. Bagshaw (London), elected 1846, died 14th August, 1878; Mr. R. Branwell, M.R.C.S. (Brighton), elected 1873, died 23rd September, 1878; Dr. H. Owens, M.D., M.R.C.S. (London), elected 1867, died 9th September, 1878; Captain E. W. Roberts, F.R.G.S. (Boxmoor), elected 1866, died 12th June, 1878 (of whom we have not received any Obituary Notices); and the following:—

Mr. JOHN ROBERT BURTON (a successful merchant, and one of the founders of the “British Empire Life” and “Perpetual Building Society,” on the management of which he continued to the last) died at his residence, Huskards, Ingatestone, on the 20th November, 1878. He was elected a Fellow of the Society in 1861, and though rarely seen at the meetings, was much attached to the use of the Microscope, and occupied himself in his leisure hours with mounting objects.

Mr. GEORGE GUYON was a descendant (the great-grandson) of the famous French Huguenot family of Guyon; the head of which, Guyon de Geis, Sieur de Pampelona, came over to England at the Revocation of the Edict of Nantes, and took service under William III. He was born at Richmond, in Surrey, on March 10th, 1824, after the younger of the senior members of his family had grown up. One of these, General Guyon, became famous subsequently for his defence of Kars (in conjunction with Sir Fenwick Williams) against the Russians.

From his birth Mr. Guyon was so delicate as to preclude the possibility of his being educated for any profession. He very early exhibited the strongest predilection for science, and especially for natural science, devoting himself at one period of his life largely to Entomology. He leaves an extensive and valuable collection of Coleoptera. He later took up the Microscope enthusiastically, and became an expert and dexterous manipulator. His neatness in mounting objects was remarkable, and he had accumulated a large number of specimens illustrative of various branches of natural history. By his physician's order, he was for some years compelled to pass the winter at Ventnor, which he ultimately made his permanent residence, and where he erected an astronomical observatory, furnished with a fine equatorial, &c.

There were few more delightful men in society than Mr. Guyon. His varied and extensive reading supplied an inexhaustible fund of conversation; while his numerous accomplishments, and unflagging readiness to enter into any scheme of amusement or instruction, rendered him a favourite both with old and young. Nor was his pen idle. He contributed, *proprio nomine*, and under his initials “G. G.,” pretty frequently to ‘Science-Gossip’; appearing at other times as “Vectensis” in the ‘English Mechanic.’ Lastly, he was a munificent anonymous donor to nearly all the leading charities in England.

* Pressure on our space made it necessary to omit this in the last number. It should have accompanied the Report of the Council.

He was elected a Fellow of this Society in 1858, and died 25th February, 1878, in his fifty-fourth year.

Dr. EDWARD JAMES SHEARMAN, M.D., F.R.S.E., F.L.S., &c., who died at Rotherham on the 2nd October, 1878, in his eighty-first year, was born at Wrington, in Somersetshire, next door to the celebrated Hannah Moore, and received his early education at Mr. Catlow's School, at Mansfield, where he was articled to a surgeon. He passed the Apothecaries' Company in 1820, having had the opportunity of studying under Brodie (afterwards Sir B. C. Brodie), at St. George's Hospital, and settled at Rotherham about 1823, where he very soon took a leading position as a general practitioner in the town and neighbourhood. He afterwards passed the College of Surgeons, and some ten years ago was made a Fellow. He took the degree of M.D. of Jena in 1841, and became a Member of the Royal College of Physicians, London, in 1869, having obtained the extra Licentiate in 1843.

His contributions to medical literature have been numerous and varied in almost all the journals of his time. In 1845 he published an "Essay on Properties of Animal and Vegetable Life." In 1846 he was elected one of the Council of the Provincial Medical Association, and in 1847 was appointed to write the "Retrospective Address on Diseases of the Chest," which was read by his son in 1848 at the annual meeting, and was afterwards published by the Council. He was elected a Fellow of the Royal Society of Edinburgh, of the Medico-Chirurgical Society, and of several other learned bodies. In 1856 he was elected a Fellow of this Society, having been early associated with the pioneers of the Microscope in medicine, and he continued to the last to manifest a most striking love for microscopical science, in diagnosis of disease, of which he had early become an adept. More than twelve months before Dr. Golding Bird published his first edition of 'Urinary Deposits,' he read before the Sheffield Medico-Chirurgical Society an "Essay on the Changes in the Urine affected by Disease," and the tests to distinguish them, which was published in the 'Lancet'; and the information which he gave to the town on sanitary matters was very interesting, exposing the evils which existed at the time, which attached more particularly to bad water and faulty drainage. His microscopical examinations of the water caused great alarm, and thoroughly opened the eyes of the people to the unsanitary condition of the town as regarded sewage and water, and paved the way for a new and better era.

He was married twice, first to the daughter of Mr. Brooks, of Old Moor, Wath, by whom he had three children; the death of his surviving son, Dr. Charles, who died about fourteen years ago, aged fifty, was a great blow to him, as he was a man of acumen and great promise in his profession. In 1872 he was married to Miss Turner, of South Grove, who survives him. Dr. Shearman was held in the highest esteem by large numbers, not only of friends, but of patients in various parts of the country, who had been in the habit of constantly consulting him.

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Comptes Rendus, LXXXVIII., No. 12.
- ELFVING, F.—Studies on the Pollen-grains of the Angiosperms. (3 plates.)
Jen. Zeitschr. f. Nat., XIII., Part 1.
- GILBERT, W. H.—On the Floral Development of *Helianthus annuus*. (1 plate.)
Journ. Quek. Micr. Club, No. 39.
- GODLEWSKI, Prof. Dr. E.—On the Knowledge of the Causes of the Changes of Form in Etiolated Plants.
Bot. Zeit., XXXVII., Nos. 6-11.
- KRAUS, C.—Contributions to the Knowledge of the Movements of Growing Foliage and Flower Leaves (*concluded*).
Flora, LXII., Nos. 4 & 6.
- LUNDSTRÖM, A. N.—Elias Fries (Memoir and Portrait).
Jou n. Bot., VIII., No. 194.
- SCHNETZLER, Prof. J. B.—Some Observations on the Colouring Matter of Chlorophyll.
Bull. Soc. Vaud. Sci. Nat., XV., No. 80.
- TANGL, Prof. Dr. E.—The Protoplasm of the Pea. II. (4 plates.)
SB. K. Ak. Wiss. Wien., LXXXVIII. (Sec. I.), Part 1.
- TOMASCHEK, A.—On Internal Cells in the Large Cell (Antheridium-cell) of the Pollen of certain Conifers. II. (1 plate.)
SB. Ak. Wiss. Wien., LXXXVIII. (Sec. I.), Part 1.

B. CRYPTOGAMIA.

- ITALIAN CRYPTOGAMIC HERBARIUM. Second Series. Fasc. 14, Nos. 651-700. (Milan, 1878.)
- LEWIS, T. R., M.B.—See Zoology A.
- MARCHAND, Dr. LÉON.—Cryptogamic Botanical Rambles. (1 plate.)
Journ. de Micr., III., No. 3.
- SCHMIDT, A.—Biographical Sketch of C. H. Funck.
Flora, LXII., No. 7.
- STEVENSON, Rev. J.—Report on the Scientific Portion of the (Scottish) Cryptogamic Society's Exhibition on October 11th, 1878.
Scot. Nat., V., No. 33.
- WHITE, F. B., M.D., F.L.S.—Glen Tilt; its Fauna and Flora (*continued*).
Scot. Nat., V., No. 34.
- The Cryptogamic Flora.

Algæ.

- CLEVE, Prof. Dr. P. T.—Diatomaceæ of the West Indian Archipelago (*concluded*).
Journ. de Micr., III., No. 3.
- DEBY, J.—Observations on an Article entitled "The Thallus of the Diatomaceæ," by Dr. M. Lanzi.
Brebissonia, I., No. 8.
- KITTON, F., and SMITH, Prof. H. L.—*Hyalodiscus subtilis* and *H. Californicus*, by F. Kitton and reply of Prof. H. L. Smith. (Translated from 'Am. Journ. Micr.')
- MUNIER-CHALMAS.—See Wright, E. P.
- PETIT, P.—Diatoms collected on *Conomitrium capense* Mull.
Brebissonia, I., No. 8.
- REPORTS of the Commission on the Desmazières Prize, awarded to Dr. Bornet for his 'Études Phycologiques,' and on the Thore Prize awarded to Prof. Ardissonne for his 'Floridee Italiche.'
Comptes Rendus, LXXXVIII., No. 10.
- SCHNETZLER, Prof. J. B.—Notice on the Colouring Matter of *Porphyridium cruentum* Naeg.
Bull. Soc. Vaud. Sci. Nat., XV., No. 80.
- SMITH, Prof. H. L.—Description of New Species of Diatomaceæ (*continued*). (Translated from 'Am. Quart. Micr. Journ.')
- STAHL, E.—On the Resting State of *Vaucheria geminata*. (1 plate.)
Bot. Zeit., XXXVII., No. 9.

- STODDER, C.—Notes on the Diatomaceæ of Santa Monica (California).
(Translated from 'Am. Journ. Micr.) *Journ. de Micr.*, III., No. 3.
TIEGHEM, P. VAN.—On the 'Gum' of Sugar works (*Leuconostoc mesenteroides*).
Ann. Sci. Nat. (Bot.), VII., No. 3.
WRIGHT, E. P.—Fossil Calcareous Algæ. (Review of Papers by M. Munier-
Chalmas.) *Nature*, XIX., No. 491.

Lichenes.

- CROMBIE, Rev. J. M., F.L.S.—Correlation of the Lichens in Robert Brown's
'Chloris Melvilliana.' *Journ. Bot.*, VIII., No. 196.
LINDSAY, W. LAUDER, M.D., F.R.S.E., F.L.S.—Fossil Lichens.
Trans. & Proc. Bot. Soc. Edin., XII., Part 2.
MÜLLER, Dr. J.—Lichenological Contributions (contd.). *Flora*, LXII., No. 11.
STIRTON, J., M.D., F.L.S.—Description of New Scottish Lichens.
Scot. Nat., V., No. 33.

Fungi.

- BERKELEY, Rev. M. J.—Mycology. *Nature*, XIX. No. 492.
COOKE, M. C., M.A., LL.D.—Enumeration of *Polyporus*.
Trans. & Proc. Bot. Soc. Edin., XIII., Part 2.
CRESPIGNY, Dr. DE.—Another Fungus Ramble in Epping Forest. (13 figs.)
Sci. Goss., No. 172.
FARLOW, W.—On the Synonymy of some Species of Uredinæ.
Proc. Am. Ac. Arts & Sci. (Boston), V.
FELTZ, V.—Experimental Researches on a Leptothrix, found during life in
the Blood of a woman attacked with severe Puerperal Fever.
Comptes Rendus, LXXXVIII., No. 11.
FRIES, E.—Icones Selectæ Hymenomycetum nondum delineatorum, Vol. II.,
Parts 2 and 3. (Plates 111–130.) (Fol. Stockholm, 1878.)
GILLET, C. C.—The Fungi of France. The Discomycetes, Part 1 (6 plates).
(Svo. Alençon, 1878.)
HOWSE, T., F.L.S.—The Cryptogamic Flora of Kent—*Fungi*.
Journ. Bot., VIII., No. 195.
KEITH, Rev. J., A.M.—Supplementary List of Fungi found within the
Province of Moray (concluded).
Scot. Nat., V., Nos. 33 & 34.
SACCARDO, P. A.—Fungi Italici autographice delineati. Parts 9–12. (4to.
Padua, 1878.)
Mycotheca veneta sistens fungos venetos exsiccatos,
Cent. XIV. (Padua, 1879.)
SADLER, J.—Notice of a New Species of Agaric (*Agaricus (Clitocybe) Sadleri*,
Berkeley) (1 plate). *Trans. & Proc. Bot. Soc. Edin.*, XIII., No. 2.
SCHULZER, S.—Mycological Notes. *Flora*, LXII., No. 9.
SCHUTZENBERGER, P., and A. DESTREM.—On Alcoholic Fermentation.
Comptes Rendus, LXXXVIII., No. 11.
STIRLING, A. B.—Notes on the Fungus Disease affecting Salmon (1 fig.).
Proc. Roy. Soc. Edin., IX., No. 100.
THÜMEN, F. VON.—Diagnoses to Thümen's 'Mycotheca universalis,' Cent.
X.—XII. *Flora*, LXII., Nos. 4 & 7.

Characeæ.

- BENNETT, A. W., M.A., B.Sc., F.L.S.—A few last words on *Chara*.
Journ. Bot., VIII., No. 195.

Muscineæ.

- BAGNALI, J. E.—Moss Habitats (continued). *Mid. Nat.*, II., No. 16.
BRIN and CAMUS.—Bryological Notice on the Environs of Cholet (continued).
Rev. Bry., VI., Nos. 1 & 2.
FERGUSON, J.—Notes on some British Mosses.
GEHEEB, A.—On the New Mosses discovered by M. Broidler in the Styrian
and Lungovian Alps in 1878. *Rev. Bry.*, VI., Nos. 1 & 2.
Notes on some rare or little-known Mosses.
JAEGER, Dr. A., and FR. SAUERBECK—Conspectus Systematis Generum Mus-
corum et Summa Specierum. *Rev. Bry.*, VI., Nos. 1 & 2.
List of European Bryologists. 4th Supplement. „ „

RENAULD, F.—Notice on some Mosses of the Pyrenees (*continued*).

Rev. Bry., VI., Nos. 1 & 2.

VENTURI.—Study of *Orthotrichum Schubartzianum*, *O. Venturii*, and *O. urnigerum*.

Rev. Bry., VI., Nos. 1 & 2.

Vascular Cryptogams.

BAKER, J. G., F.R.S., F.L.S.—Report on a Collection of Ferns made in the North of Borneo by Mr. F. W. Burbidge.

Journ. Bot., VIII., No. 194.

„ „ Report on Burbidge's Ferns of the Sulu Archipelago.

Journ. Bot., VIII., No. 195.

ROSS, GEORGE.—On the Flora of Mull.

Trans. & Proc. Bot. Soc. Edin., XIII., No. 2.

MICROSCOPY, &c.

ADAM, H. Ph.—The Invisible World revealed, Parts 9-16 (*conclusion*). (8 plates.) (8vo. Brussels and Paris, 1879.)

DIPPEL, Dr. L.—The Objectives for Homogeneous Immersion of Carl Zeiss

Flora, LXII., No. 11.

EXAMINATION of Powders: a new Employment for the Microscope (from 'Young Scientist').

Am. Journ. Micr., IV., No. 2.

MARSH, Dr. S.—Knives for cutting Sections (from 'Section Cutting'). (3 figs.)

Am. Journ. Micr., IV., No. 2.

MOREHOUSE, G. W.—On Searching for Trichinæ. *Am. Journ. Micr.*, IV., No. 2.

NEWTON, E. T., F.G.S.—On a new Method of preparing a Dissected Model of an Insect's brain from Microscopic Sections. (5 woodcuts.)

Journ. Quek. Micr. Club., No. 39.

PELLETAN, Dr.—On Microscopic Preparations. *Journ. de Micr.*, III., No. 3.

„ „ Self-centering Whirling Table of W. Bulloch. (1 fig.)

Journ. de Micr., III., No. 3.

PETIT, P.—Preparation of Diatoms in situ. Means of Avoiding Air-bubbles.

Brebissonia, I., No. 8.

QUINCKE, Prof.—Extracts from two Letters on the Refractive Indexes of Glass and Quartz, as tested by reflection from the surface.

Proc. Roy. Soc. Edin., IX., No. 100.

ROLLESTON, Prof., F.R.S.—Note on the Preservation of Encephala by the Zinc Chloride.

Journ. Anat. & Phys., XIII., Part. 2.

SCHULZE, A.—An Easy and Simple Method of Resolving the finest-lined Balsamed Diatomaceous tests by transmitted Lamp-light, &c. (from this Journal).

Am. Journ. Micr., IV., No. 2.

UNIVERSAL Sub-Stage for Oblique Light.

Am. Journ. Micr., IV., No. 2.

VANDEN BROECK, E.—Medley of Microscopy. Notices, &c., presented to the Belgian Society of Microscopy. (8vo. Brussels, 1879.)

WILKINS, T. S.—Microscopic Pond Life (*continued*).

Am. Journ. Micr., IV., No. 2.

PROCEEDINGS OF THE SOCIETY.

MEETINGS OF 9TH APRIL, 1879, AT KING'S COLLEGE, STRAND, W.C.
DR. BEALE, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 12th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Ardissone, F.— <i>Le Floridee Italiche descritte ed illustrate</i> . Vol. i. fasc. v., 2 plates, 8vo. Milan, 1874	<i>The Author.</i>
— <i>La Vie des Cellules et l'Individualité dans le Règne Végétal</i> . Traduit par A. Champseix. 8vo. Milan, 1874	<i>Ditto.</i>
Carus, J. Victor, and W. Engelmann.— <i>Bibliotheca Zoologica</i> . 2 vols. 8vo. Leipzig, 1861	<i>Dr. Beale.</i>
Gegenbaur, C.— <i>Grundzüge der Vergleichenden Anatomie</i> . (319 woodcuts.) 2te Aufl. 8vo. Leipzig, 1870	<i>Ditto.</i>
Home, Sir Everard, Bart.— <i>Lectures on Comparative Anatomy</i> . (171 plates.) Vols. iii. and iv. 4to. London, 1823	<i>Mr. Crisp.</i>
Orth, Dr. J.— <i>A Compend of Diagnosis in Pathological Anatomy</i> . Translated by Dr. F. C. Shattuck and Dr. G. K. Sabine. Revised by Dr. R. H. Fitz. (2 plates). 8vo. Boston, 1879	<i>Ditto.</i>
Pelletan, Dr. J.— <i>Le Microscope: son Emploi et ses Applications</i> . (4 plates and 278 woodcuts.) 8vo. Paris, 1876	<i>Dr. Beale.</i>
Roper, F. C. S.— <i>Flora of Eastbourne</i> . 8vo. London, 1875	<i>The Author.</i>
Siebold, C. Th. v., and H. Stannius.— <i>Comparative Anatomy</i> . Translated from the German and edited by Dr. W. J. Burnet. Vol. i. <i>Anatomy of the Invertebrata</i> . 8vo. London and Boston, 1854	<i>Dr. Beale.</i>

The Books which the Council had decided to purchase out of the Quekett Fund, in pursuance of their last Report, were stated to be the following:—

- Encyclopædia Britannica*. 9th ed. Vols i.-ix. 4to. Edinburgh, 1875-9.
Botanischer Jahresbericht. Vols. i.-iv. 8vo. Berlin, 1874-8.
Zoological Record. Vols. i.-xiii. 8vo. London, 1875-78.
 Ehrenberg, C. G.—*Mikrogeologie*, and Continuation. Fol. Leipzig, 1854-6.
 Gegenbaur, C.—*Elements of Comparative Anatomy*. (Translated by Bell and Lankester.) 8vo. London, 1878.
 Haeckel, E.—*Die Radiolarien*. Fol. Berlin, 1862.
 Hertwig, R.—*Der Organismus der Radiolarien*. 4to. Jena, 1879.
 Huxley, T. H.—*Manual of the Anatomy of Vertebrated Animals*. 8vo. London, 1871.
 — *Manual of the Anatomy of Invertebrated Animals*. 8vo. London, 1877.
 Nicholson, H. A.—*Manual of Zoology*. 5th ed. 8vo. Edinburgh and London, 1878.
 — *Manual of Palæontology*. 8vo. Edinburgh and London, 1872.
 Ranvier, L.—*Traité technique d'Histologie*. Fasc. 1-5. 8vo. Paris, 1875-8.
 Stein, F. Ritter von.—*Der Organismus der Infusionsthiere*. Parts I. II and III. (1st Half). Fol. Leipzig, 1859-78.
 Thuret, G., and E. Bornet.—*Études Phycologiques*. Fol. Paris, 1878.

The books were laid upon the table.

Mr. Stewart called attention to two slides exhibited by Mr. Dreyfus, one of which (*Poteriodendron petiolatum*) was one of the remarkable flagellate Infusoria (figured in Stein's work), in the form of a tree goblets of glass-like transparency, an outline of which he drew on the board. It had been found in one of the ponds at the Zoological Gardens. The other slide was a fungus (*Gymnosporangium*), one of the *Uredineæ*.

Mr. Crisp called attention to the fact of Messrs. Powell and Lealand having constructed a $\frac{1}{8}$ oil-immersion objective, which they had brought for exhibition.

Professor Keith's "Note on Diagrams exhibiting the path of a ray through Tolles' $\frac{1}{8}$ Immersion Objective" was read by Mr. Crisp (see p. 269 and Plate XII.) and the diagrams exhibited. The original diagram copied on p. 143 of vol. i. and computation forming Plate VII. of that volume were also shown.

Mr. Wenham's "Reply to Professor Keith's Note" (see p. 270) was read (see p. 271).

Mr. Crisp stated that the Council had come to the conclusion that it was desirable to close the controversy on the aperture question, and that, with the possible exception of a paper promised by Professor Abbe, it was not intended to print any further communications on the subject beyond those read this evening.

Mr. Tolles' paper on "An Illuminating Traverse-Lens" was read by Mr. Crisp, and the apparatus exhibited and illustrated on the black-board.

Dr. Edmunds said that homogeneous immersion was nothing less than a new point of departure for high-power objectives—such lenses going as far beyond water lenses as these go beyond air lenses. The enormous resolving power of homogeneous immersion lenses could only be brought out by corresponding illumination. For such illumination the immersion principle was indispensable. He had long worked with immersion illuminators, and found them perfectly easy to manage. A crown lens, half an inch in radius and in depth an entire hemisphere minus the thickness of the slide, would, when connected to the slide with oil, do almost everything in the way of oblique illumination, and no Microscope was now complete without such an accessory. The travelling plano-concave addendum of Mr. Tolles, though very pretty in theory, was not, he thought, of much use as a working tool.

Dr. Hudson's "Note on Mr. Deby's paper" (as to the identity of *Pedalion* Hudson and *Hexarthra* Schmarda—see p. 111) was read by Mr. Crisp, and the two comparative drawings made by Dr. Hudson enlarged on the board by Mr. Stewart.

Mr. Crisp said that at the last meeting mention was made (see p. 220) of some experiments which Professor Abbe was conducting with the view of finding some immersion fluid that could be substituted for oil, and chloride of zinc was referred to as a possible fluid. After the meeting, however, some of the Fellows expressed the opinion that chloride of zinc would dissolve the brass setting of the objectives, in consequence of which Mr. Stephenson had communicated with Professor Abbe on the subject, and in reply he said that "what he spoke of was not the ordinary chloride of zinc, obtained by dissolving zinc in hydrochloric acid, but the chloride released from water (anhydric) by distilling it over. The ordinary zinc salt would not give sufficient refraction."

Mr. Zeiss had also sent over four samples of the following solutions (which were shown to the Meeting), viz. :—

- (1) Chloride of cadmium in glycerine (CdCl_2), 1·504.
- (2) Copaiva balsam oil, 1·504.
- (3) Chloride of zinc in water (ZnCl_2), 1·504.
- (4) Sulpho-carbolate of zinc in glycerine, 1·501.

The chloride of cadmium in glycerine Professor Abbe describes as somewhat too thick for convenient use, but very good in optical respects. It is literally "fluid crown glass, its dispersion being almost equal to that of ordinary crown. The oil of copaiva balsam he pronounces to be "in every respect perfectly equal to oil of cedar-wood, but not quite so fluid."

Mr. Stephenson said that just before he came to the meeting he had received a letter from Professor Abbe (7th April), in which he further said, "As to the chloride of zinc, we have tried it repeatedly, and have found no obstacle, but it does not allow a *prolonged* immersion with the same drop. After ten to fifteen minutes' exposure, it deposits small crystals, as it seems, on the slide and on the front lens, whereby the optical effect is considerably deteriorated, though all can be cleaned off by water and alcohol. In using this solution, therefore, the slide and objective should be cleaned after ten minutes' observation, and a fresh drop taken. If the objective is well cleaned at the end of the observation, wiping it finally with alcohol, there will be no damage at all. With the glycerine, good cleaning of the preparations and of the objective is also necessary, as glycerine has a very strong adhesion to glass."

Mr. Ingpen inquired if there would be any difficulty in making the ends of the fronts of the objectives of platinum?

Dr. Edmunds said that he had written to Herr Zeiss suggesting that the front lens should be set in platinum, because of its incorrodibility, and because, under variations of temperature, its coefficient of expansion was almost identical with that of crown glass. Herr Zeiss, while admitting these advantages in platinum, pointed out that its want of rigidity was fatal, inasmuch as for the fronts of these high-angled lenses, the setting had to be turned out very hollow, and to an edge little thicker than a sheet of writing paper. Such a setting if in platinum would collapse under slight pressure, and the lens

would be spoilt. Therefore Herr Zeiss used a very hard nickel alloy.

As to aqueous fluids, great caution was needed, as some of them might corrode the metal setting, and unship the front lens; some, such as zinc chloride, would be very hygroscopic, and, after a few minutes in a dry or moist atmosphere, would vary so rapidly in refractive index as to be useless for such a purpose; others would penetrate by capillary attraction past the edge of the lens, and gum up the margin of the back surface, so as to reduce the working angle of the lens and introduce diffraction phenomena. Therefore an oily fluid would probably after all prove the best. Shellac was proof against cedar oil, and would answer perfectly for mounting objects, and perhaps also for consolidating the front lens in its narrow setting, so as to prevent capillary action at its margin.

A letter was read from Mr. Adolf Schultze, of Glasgow, well known as an expert manipulator, in which he said that "though he had not had time to examine these fluids closely, yet he was able to say that by their use with the $\frac{1}{18}$ he at once resolved *A. pellucida* and other fine diatomaceous tests as distinctly as with cedar-wood oil. The cadmium chloride in glycerine and sulpho-carbolate of zinc in glycerine being very thick and sticky, might, he thought, suit the $\frac{1}{8}$ well, as it has a very large working distance. Copaiva balsam oil he thought on the whole the best substitute for cedar-wood oil. Although these liquids do not act as solvents on the Canada balsam and the varnish rings of objects, and (with the exception of the copaiva) are free from smell, yet he doubts whether their use offers any important advantages over cedar-wood and fennel oil, whose smell is not offensive if employed in very small quantities. Three of the four fluids require to be washed off from the slide and the front lens with water, whilst for copaiva and the other oils a little blotting paper suffices."

With regard to the $\frac{1}{8}$ oil-immersion, Mr. Schultze also said:—"It is my opinion that this lens is at present perhaps the finest immersion objective of the same focus made, and that it is not likely soon to be surpassed. My specimen (No. 3) has a magnifying power of 980 diameters, with Ross's A eye-piece, and a working distance of about 0.004 inch, its definition is very fine, and its resolving power is as remarkably great as that of the $\frac{1}{8}$ and the $\frac{1}{12}$ of the same series. Its field is quite flat, as far as I can see on the tests at my command, and it gives a great deal of light, so much so that when using a microscopic lamp with a wick half an inch broad, the markings of *A. pellucida* are still visible under Ross's F eye-piece, or under a power of 8000 diameters. Apart from magnification and working distance there seems little to choose regarding other optical qualities between Zeiss's three objectives of $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{18}$ inch focus on the homogeneous immersion system."

Mr. Stephenson, in reading his paper on "The Vertical Illuminator and Oil-Immersion Objectives" (see p. 266), said that it was now found that the kind of illumination furnished by the vertical illuminator

was exceedingly valuable in the case of large-angled objectives. He had no valve of *Amphipleura pellucida* which he had not been able to resolve although he had been often told by opticians that some of his slides were of no value, being quite "washed out"; as for *Surirella gemma*, the whole valve was seen to be covered with knobs. Mr. Morehouse, in the extract quoted in the last number of the Journal (p. 194), pointed out that the vertical illuminator would only work well with large aperture lenses, and it would be found that it was only with very large angles, exceeding 180° , that it acted effectively.

Mr. Curties asked what Mr. Stephenson considered the best form of illuminator.

Dr. Edmunds said he would be glad to know whether Mr. Stephenson had compared the reflecting prism, the disk of thin glass, and the opaque steel mirror as practical tools? Would it be best to work the illuminator from the side of the Microscope tube, or in the optic axis, and at what point behind the objective would the reflector work best on the object, and do the least damage to the image received by the eye-piece?

Mr. Stephenson said that the apparatus he had used was the one with a parallel plate of glass. In one respect a small prism was no doubt better, because with the plate of glass light was received from both surfaces, which tended to confuse the image. The prism was certainly better than the steel disk, and it was essential that it should be placed at the side of the tube. Of course just so far as the prism projected over the edge of the objective, the aperture of the glass would be diminished. Dr. Carpenter gave the preference to the thin glass disk over the fixed parallel plate, both on account of its superior reflecting power, and the ease with which it could be set at any inclination.

Mr. Crisp said that Mr. Stephenson's demonstration of the excess of aperture over 180° was the most interesting that had yet been suggested on that subject. With regard to slides of *Amphipleura* being washed out, he had been frequently assured when objectives were being tried on his own slides, that the slides were "not those of the *Amphipleura* which had markings, but a variety which had no markings." It should be mentioned that Mr. Adolf Schulze had early last year discovered the power of the vertical illuminator, when used with oil-immersion objectives, to resolve *Amphipleura*. He unfortunately delayed the publication of the method through an accident.

The President being obliged to leave, the chair was taken by Dr. Braithwaite, V.P.

Mr. Crisp brought forward the resolution of which he gave notice at the last meeting, as to a standard unit of micrometry. He said that he had little to add to what he then stated. His motive in bringing the resolution forward was, 1st, that they as the oldest Microscopical Society in existence, should express an opinion one way or the other on a subject which was considerably agitating their fellow workers in America, and 2nd, his conviction that it would be a grievous error for

any body of microscopists to adopt the $\frac{1}{100}$ of a millimetre for the standard as had been recommended.

Dr. Edmunds in seconding the resolution said that the $\frac{1}{100}$ of a millimetre was clearly too large, while the $\frac{1}{10000}$ being less than one-seventh the diameter of a human blood-corpuscle, showed that it was sufficiently small for all the work of practical histology.

Mr. Stephenson said that he entirely agreed with the views which Mr. Crisp had expressed as to the $\frac{1}{100}$ of a millimetre, which was obviously much too high a standard, leading as it constantly would to the use of fractions of the unit which it ought to be one of the essential qualities of a standard to avoid. At the same time he considered that the time had not arrived when they ought to formulate in a resolution a positive injunction as to the use of any given standard. So far as that was desirable, it had already been done by the Leyden resolution of Professor Suringar. He would therefore move—

“That in the opinion of this Society, the $\frac{1}{100}$ of a millimetre is too large a unit for micrometric measurements, and that it is not expedient at present to prescribe by any formal resolution the adoption of a fixed standard for micrometry.”

Mr. Michael thought that if they were to have a standard at all the one proposed was perhaps the best to be adopted. But the question in his mind was, whether it was desirable or convenient to establish a special standard for the purpose of microscopy alone? The greater part of the work requiring measurements was done by those who engaged in it as a part of their ordinary work, and in such case it would be difficult to say what was microscopic work to which this new standard was to apply in place of the ordinary methods of measurement. He thought therefore that the adoption of a new standard required very grave consideration.

Mr. Curties was certainly not in favour of attempting to come to any decision now as to the adoption of a standard.

The Chairman, having put the amendment to the Meeting, declared it to be carried.

A letter from Professor R. Hitchcock, of New York (of 12th March), as to standard micrometers, was read by Mr. Crisp, of which the following is an extract:—“As to standard micrometers, I cannot understand why there is so much opposition to adopting a standard division. I believe that such a division will be adopted here, and that the metric system will supersede all others. It requires only a slight familiarity with micrometers ruled on this system to convince anyone of their superiority. As to the question of accuracy, I assume, and with propriety, that divisions of $\frac{1}{100}$ mm., or $\frac{1}{1000}$ inch, can be ruled so that the variations from a given standard are measured by *millionths of an inch*, varying from ± 0 to ± 25 millionths at a given temperature. I have a “standard cm.” in which the average variation in the spacing is not far from 10 millionths of a mm., according to the determinations of Professor Rogers, the maker. (I speak from memory; it may be a little more than this, but some of the

variations are only 3 millionths.) The only question remaining is, is the standard from which the work is done true? Well, I believe it will be shown that it is; but suppose not, is it not infinitely better to have a standard measure, even though it be not an *absolutely accurate* subdivision of a metre or inch, so long as it is possible to make all standards agree, than to have so much confusion as we find at present? I hope your Society will take this view of it, and I am sure that any man who has ever undertaken to prepare a standard micrometer for his own use from a comparison of those in the market, will need no argument to convince him of the value of this undertaking. Why should we go on, year after year, publishing microscopic dimensions from micrometers which we know are not true? All such work will need revision in the future, if it is of any value at least.

I did not mean to say all this. However, I do hope your Society will have something to say about this matter, and co-operate heartily with what may be done here. The matter is in good hands on this side of the water, and what action is taken will be final I believe. Above all things, let us try to avoid the adoption of one standard here and another in England."

Mr. Crouch said that, having had the pleasure of seeing Professor Rogers and his machine, he thought it was not at all likely that anyone on this side of the Atlantic would be disposed to go to the expense that had been gone to in the matter by that gentleman.

The Chairman announced that the second Scientific Evening of the Session would be held on the 21st May, in the Library of King's College.

A SPECIAL GENERAL MEETING was then held pursuant to notice.

Dr. Braithwaite moved, and Mr. Stewart seconded, the following resolution:—

That Bye-law 7 be amended by substituting "31*l.* 10*s.*" for "21*l.*"

He said that it had been pretty generally found by the scientific Societies that the Composition Fee was too low; the Linnean Society had recently raised it from 30*l.* to 45*l.*, and the Council now recommended a proportionate increase. It would, of course, apply only to Fellows nominated after this date.

Dr. Edmunds considered that it was not desirable that the Composition Fee should be increased.

The resolution was put to the Meeting and carried, with three dissentients.

Mr. Crisp moved, and Dr. Matthews seconded, the following resolution:—

That Bye-law 15 *b* (see p. 212) be amended by inserting the following words at the end of the first paragraph thereof—
"or of the Presidents or Chairmen of the Biological or Microscopical sections of such Societies."

It had been found that some of the Societies nominated under the

Bye-law had separate Biological or Microscopical sections, and it was considered to be more appropriate that in such cases the President or Chairmen of those sections should be Ex-officio Fellows rather than the Presidents of the Societies. In the Royal Societies of the Australian colonies, for instance, the Governor of the colony was generally the President.

The resolution was carried unanimously.

The following objects and apparatus were exhibited:—

Mr. Dreyfus:—(1) *Poteriodendron petiolatum* (Flagellate Infusoria). (2) *Gymnosporangium* (Fungus).

Messrs. Powell and Lealand:— $\frac{1}{8}$ oil-immersion objective of their own manufacture, shown with *P. angulatum*.

Mr. Stephenson:—Vertical illuminator, with Zeiss' oil-immersion $\frac{1}{8}$ objective, shown with *Surirella gemma* and *Amphipleura pellucida*.

Mr. Ward:—Section of stem of *Hedysonia heteroclita* (Himalayahs).

Mr. Crisp:—(1) Dr. H. Hager's Compressor-Microscope for Trichinae, &c., combining a Compressorium and a Microscope (Hager, 'Das Mikroskop,' 6th ed., Berlin, 1879, p. 41). (2) Beck's achromatic condenser (see p. 328). (3) Two slides of compound vibration curves by Mr. Washington Teesdale. (4) Professor Keith's original computation and diagram, vol. i. plate vii. and p. 143, and the further drawing described in his last paper, vol. ii. p. 269 and plate xii.

New Fellows.—The following were elected *Fellows*, viz.:—Captain Cyril Frampton, R.M.; Dr. W. M. Ord, M.D., F.R.C.P.; and Messrs. F. M. Campbell, G. Chandler, G. D. Plomer, G. W. Ruffle and J. J. Vezey.

Honorary Fellows.—Rev. M. J. Berkeley (Sibbertoft, Market Harborough); G. R. Waterhouse (London); W. Archer (Dublin); L. Pasteur and L. Ranvier (Paris); P. J. Van Beneden (Louvain); A. de Bary (Strassburg); F. Cohn (Breslau); A. v. Kölliker (Würzburg); C. Nägeli (Munich); S. Schwendener (Berlin); A. Grunow (Berndorf, near Vienna); F. Ritter von Stein (Prague); M. J. Schleiden (Dorpat); J. Leidy (Philadelphia).

Societies whose Presidents for the time being are Ex-officio Fellows under Bye-Law 15b.

UNITED KINGDOM.

London and Suburbs.

Quekett Microscopical Club
South London Microscopical and Natural History Club
Croydon Microscopical and Natural History Club

Provinces.

Birmingham Natural History and Microscopical Society
Brighton and Sussex Natural History Society
Bristol Microscopical Society

Bristol Naturalists' Society
(Canterbury.) East Kent Natural History Society
Cardiff Naturalists' Society
Eastbourne Natural History Society
Leeds Philosophical and Literary Society
Liverpool, Literary and Philosophical Society of
Liverpool, Microscopical Society of
Manchester, Literary and Philosophical Society of
(Norwich.) Norfolk and Norwich Naturalists' Society

(Newcastle-upon-Tyne.) North of England Microscopical Society
(") Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne
Plymouth Institution and Devon and Cornwall Natural History Society

Scotland.

Glasgow, Natural History Society of (Perth.) Cryptogamic Society of Scotland
(") Perthshire Society of Natural Science

Ireland.

Dublin Microscopical Club
Belfast, Natural History and Philosophical Society of

COLONIES.

India.

(Calcutta.) Asiatic Society of Bengal

Australasia.

New South Wales, Linnean Society of
New South Wales, Royal Society of
Tasmania, Royal Society of
Victoria, Royal Society of
(New Zealand.) Wellington Philosophical Society

Canada.

(Halifax.) Nova Scotian Institute of Natural Science
Montreal, Natural History Society of
(Toronto.) Canadian Institute

UNITED STATES.

(Boston.) American Academy of Arts and Sciences
Boston Society of Natural History
(Chicago.) State Microscopical Society of Illinois
New York Academy of Sciences
New York Microscopical Society
Philadelphia, Academy of Natural Sciences of
San Francisco Microscopical Society
Troy Scientific Association

GERMANY.

Berlin, Gesellschaft Naturforschender Freunde zu
(Dresden.) Naturwissenschaftliche Gesellschaft "Isis"
(Frankfurt a M.) Senckenbergische Naturforschende Gesellschaft
Göttingen, K. Gesellschaft der Wissenschaften zu

Jenaische Gesellschaft für Medicin & Naturwissenschaft
(Leipzig.) K. Sächsische Gesellschaft der Wissenschaften

AUSTRIA-HUNGARY.

Wien, K.K. Zoologisch-botanische Gesellschaft in

HOLLAND.

Haarlem, Hollandsche Maatschappij der Wetenschappen te (Société Hollandaise des Sciences à Harlem)

SWITZERLAND.

Basel, Naturforschende Gesellschaft in
Bern, Naturforschende Gesellschaft in
Genève, Société de Physique et d'Histoire Naturelle de
(Lausanne.) Société Vaudoise des Sciences Naturelles
Zürich, Naturforschende Gesellschaft in

FRANCE.

(Amiens.) Société Linnéenne du Nord de la France
Lyon, Société Linnéenne de
Montpellier, Académie des Sciences et Lettres de
(Paris.) Société Botanique de France
(") Société Cryptogamique de France

BELGIUM.

(Brussels.) Société Belge de Microscopie
(") Société Royale de Botanique de Belgique

ITALY.

Milano, Istituto Lombardo di Scienze e Lettere di
(") Società Crittogamologica Italiana
(Pisa.) Società Toscana di Scienze Naturali
Torino, R. Accademia delle Scienze di
(Venezia.) R. Istituto Veneto di Scienze, Lettere, ed Arti

SPAIN.

(Madrid.) Sociedad Española de Historia Natural

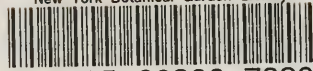
RUSSIA.

Moscou, Société Impériale des Naturalistes de
(Odessa.) Société des Naturalistes de la Nouvelle Russie





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